

FORENSIC BIOLOGY SECTION



CASEWORK TEST METHODS

**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS**

FOREWORD

The Laboratory Division of the Indiana State Police (ISP) conducts tests on various body fluids, body fluid stains, and human hair for criminal justice agencies. DNA analysis is performed as needed on the various biological materials. The Laboratory reserves the right to evaluate and prioritize the items submitted and limit the total number in order to expedite service. The analysts of the Forensic Biology Section shall have a minimum of a baccalaureate or an advanced degree in a natural science or a closely related field. DNA analysts shall have successfully completed college course work covering the subject areas of genetics, biochemistry, molecular biology and statistics. All analysts undergo an intensive formalized training program dealing with forensic techniques and instrumentation. Completion of the Training Program is required before analysis of evidence is performed. Additionally, all analysts participate in proficiency testing utilizing open trials, blind trials, and/or re-examination techniques. The accuracy and specificity of test results are ensured by running known controls with each set of tests.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS TABLE OF CONTENTS

1. **Serology Methods**

- a. [Serology Examination](#)
- b. [Phenolphthalein \(Kastle-Meyer\)](#)
- c. [Luminol](#)
- d. [Takayama](#)
- e. [Species Origin](#)
- f. [Acid Phosphatase](#)
- g. [Microscopic Examination for Spermatozoa](#)
- h. [Christmas Tree Stain](#)
- i. [Amylase](#)
- j. [Hair Examination](#)
- k. [Report Writing](#)

2. **DNA Methods**

- a. [DNA Examination](#)
- b. [Sampling Protocols](#)
- c. [Organic Extraction \(Regular\)](#)
- d. [Organic Extraction \(Differential\)](#)
- e. [Microcon® Concentration](#)
- f. [Centri-sep cleanup](#)
- g. [Maxwell® Extraction](#)
 - 1) [Regular Sample Preparation](#)
 - 2) [Differential Sample Preparation](#)
 - 3) [Maxwell® Procedure](#)
- h. [Quantifiler DUO™ Quantification](#)
- i. [PowerPlex® 16 Hot-Start with the 3500 Series Instrument](#)
 - 1) [Introduction](#)
 - 2) [Amplification](#)
- j. [Interpretation Guidelines](#)
 - 1) [Stutter Tables](#)
 - 2) [Mixture Interpretation](#)
- k. [Report Writing](#)

3. **Forensic Relationship Methods**

- a. [Interpretation](#)
- b. [Statistical Rules](#)
- c. [Report Writing](#)

4. **Y-STR Methods**

- a. [Y-STR Examinations](#)
- b. [Plexor® HY Quantification](#)
- c. [PowerPlex® Y23](#)
 - 1) [Introduction](#)
 - 2) [Amplification](#)
- d. [PowerPlex® Y23 Interpretation Guidelines](#)
 - 1) [Stutter](#)
 - 2) [Mixture Interpretation](#)

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- e. [PowerPlex® Y23 Report Writing](#)

5. **Automated DNA Methods**

- a. [Regular Extraction Preparation](#)
- b. [Differential Extraction Preparation](#)
- c. [Initial Tube Transfer Method](#)
- d. [Automated DNA IQ Extraction Method](#)
- e. [Automated Quantification Method](#)
- f. [Automated Amplification Setup Method](#)
- g. [Automated CE Plate Setup Method](#)
- h. [Final Tube Transfer Method](#)

APPENDICES:

- | | |
|---|-----------------------------|
| 1. Serology Flow Charts | Appendix 1 |
| 2. Assumed Two Person Mixture Interpretation | Appendix 2 |
| 3. Assumed Three Person Mixture Interpretation | Appendix 3 |
| 4. Statistical Analysis for Autosomal DNA Testing | Appendix 4 |
| 5. Report Wording | Appendix 5 |
| 6. Definitions | Appendix 6 |
| 7. Server Instructions | Appendix 7 |
| 8. Relationship Comparison Statistical Reference | Appendix 8 |
| 9. Powerplex ® Y23Stutter Table | Appendix 9 |
| 10. Allele Frequency Tables (Autosomal Loci) | Appendix 10 |

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

1. Serology Methods:

1.1. Scope:

This test method is designed for the guidance of laboratory personnel who assist investigations where body fluids or stains occur as physical evidence in a variety of alleged criminal activities. The scope of this type of evidence includes but is not limited to the following: identification of blood, semen, animal species, amylase and human hair. This test method may be expanded or altered as techniques and/or new genetic analyses are found applicable and validated.

- 1.1.1 Trace evidence including but not limited to hair, fibers, glass, or paint may be collected from evidence submitted for serological examination. Collected trace evidence shall be retained in the original packaging unless value is immediately apparent. Appropriate notes shall be taken on the trace evidence collected. When required, hairs shall be evaluated for the possibility of human origin and the potential for future analysis.
- 1.1.2 A search is made of submitted items for the presence of biological material. Once a questioned stain or material is detected and identified, if applicable, it is retained for possible DNA analysis.
- 1.1.3 Stain cards from whole blood samples, cuttings from body fluid stains and other DNA evidence shall be retained by the laboratory for any possible future testing.
- 1.1.4 The retained items may be released at the prosecutor's request. The request shall be documented in the case record. A valid court order shall circumvent this procedure.

1.2. Precautions/Limitations:

1.2.1. Evidence

- 1.2.1.1. Liquid items such as blood standards shall be refrigerated not frozen. Stained materials may be frozen, refrigerated or stored at room temperature in a dry environment. Items to be analyzed for latent prints should not be frozen or refrigerated.
- 1.2.1.2. Stains that are still moist shall be air dried in a secure area before submission to the laboratory.
- 1.2.1.3. Clean paper or cardboard containers shall be used to package dried evidence. Plastic containers shall not be used for packaging because they hold moisture which often leads to putrefaction of biological materials. Exceptions to this rule would include blood tubes, body tissue samples and condoms. Each item should be placed in separate containers from the point of collection.
- 1.2.1.4. If multiple items are placed in one container at time of collection, they may be submitted in the single, original package.
- 1.2.1.5. Specific examinations performed on items of serological evidence shall be determined by laboratory personnel.

1.3. Related Information:

- 1.3.1. Appendix 1 Serology Flow Charts
- 1.3.2. Work Sheet Manual

1.4. Instruments:

- 1.4.1. Balances – An analytical balance used for preparation of analytical reagents and buffers.
- 1.4.2. Centrifuges – A serofuge capable of operating at 3400 rpm and an ultra-centrifuge capable of up to 15,000 rpm, are used for separation of solid components from fluids.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 1.4.3. Alternate light source (ALS) – A light source to aid in the location of stains and trace evidence by use of various wavelengths of light.
- 1.4.4. Crosslinker - Preprogrammed ultraviolet exposure unit which is factory set to ~120,000 microjoules per cm².
- 1.4.5. Digital camera – Used to document evidence and/or the packaging.
- 1.4.6. Microscopes – A light microscope with magnification up to 400X, a stereoscope for general screening of items, and a phase contrast microscope for the identification of spermatozoa.
- 1.4.7. Miscellaneous Laboratory Equipment – Supportive laboratory equipment including ovens, incubators, pipettors, rotators, stirring/heating plates, vortex mixers, vacuum pumps, UV lights, and refrigerators/freezers for storing of reagents, buffers and evidence.
- 1.4.8. pH meter – An instrument capable of manual or automatic temperature compensation and reading +/- 0.01 pH units. Used for preparation of buffers and reagents.

1.5. Reagents/Materials: See Reagent Preparation Manual for instructions and logs.

- 1.5.1. Alpha Naphthyl Phosphate Solution
- 1.5.2. Amylase Buffer
- 1.5.3. Amylase Plates
- 1.5.4. Acid phosphatase Acetate Buffer
- 1.5.5. Acid phosphatase Dye Solution
- 1.5.6. Coomassie Blue Stain
- 1.5.7. Destain
- 1.5.8. Florence Iodine Solution (for Amylase)
- 1.5.9. Glucose, saturated
- 1.5.10. 0.176M H₂O₂ (Luminol Solution B)
- 1.5.11. 3% H₂O₂
- 1.5.12. 0.004M Luminol (Luminol Solution C)
- 1.5.13. Phenolphthalein Stock Solution
- 1.5.14. Phenolphthalein Working Solution
- 1.5.15. 0.4N Sodium Hydroxide (Luminol Solution A)
- 1.5.16. 10% Sodium Hydroxide
- 1.5.17. Species Origin Ouchterlony Plates
- 1.5.18. Takayama Solution

1.6. Hazards/Safety:

- 1.6.1. All chemicals shall be handled in a safe method as referenced in the specific SDS.
- 1.6.2. Preparation of the Phenolphthalein Stock Solution shall be performed in a chemical fume hood.
- 1.6.3. The spraying of Luminol reagent in the laboratory shall be confined to a chemical fume hood whenever practical.
- 1.6.4. Universal Precautions shall be in use whenever biological materials are being handled.
- 1.6.5. Extreme caution shall be used when handling liquid body fluid samples.
- 1.6.6. Biological waste shall be disposed of in the appropriate waste receptacle.

1.7 Reference Materials/Controls/Calibration Checks:

- 1.7.1 All commercial antisera are tested for accuracy and specificity before use in casework.
 - 1.7.1.1 Each new lot of anti-human antisera shall be analyzed against various animal sera and human blood to confirm specificity. Animal sera shall include but not be limited to deer,

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

dog, cat, cow, chicken, monkey, swine, and the species used to produce the antiserum (goat for goat anti-human; rabbit for rabbit anti-human). The worksheet used to record the results shall be retained.

- 1.7.1.2** Each new lot of animal antisera shall be analyzed against human blood and any available related species to confirm specificity. The worksheet used to record the results shall be retained.

- 1.7.2** Running known controls with each test ensures the accuracy and specificity of the test results. See the specific test for the appropriate controls to be run.

1.8. Procedures/Instructions:

1.8.1. Examination Procedure

1.8.1.1. Standards for Comparison

- 1.8.1.1.1. Appropriate standards, such as whole blood or buccal swabs, from those individuals involved should be submitted along with the questioned materials to be analyzed.
- 1.8.1.1.2. The whole blood standard should be submitted in a purple top tube that contains ethylene-diamine-tetra-acetic acid (EDTA). Prior to examination, while in the custody of the ISP Laboratory, this tube shall be refrigerated.
- 1.8.1.1.3. A stain card shall be prepared from at least one whole blood standard from each individual and shall be retained by the laboratory for future reference and analysis.
- 1.8.1.1.4. Buccal swab standards shall be retained by the laboratory for future reference and analysis. Multiple swabs from an individual shall each have a unique identifier but may be treated as one item. (i.e. swabs 1A1 and 1A2 retained in item 1A will be referred to as item 1A in the report, whether one sampled or two sampled and combined).
- 1.8.1.1.5. The analyst's notes shall indicate the presence of hair standards.
- 1.8.1.1.6. In cases where a secondary standard is needed, the item to be used as a secondary standard shall be clearly identified as such.
 - 1.8.1.1.6.1. The use of a blood stained article of clothing may be appropriate if stains from the person wearing the clothing can be definitively identified (i.e. blood from around the wound area).
 - 1.8.1.1.6.2. In the case of a missing person, personal items such as toothbrush, hairbrush, razor or other item may be submitted.
 - 1.8.1.1.6.3. When a contributor requests items to be used as secondary standards during the submission process, it should be indicated on the Request for Laboratory Examination form.

1.8.1.2. Trace Evidence

- 1.8.1.2.1. A clean piece of paper shall be used under each item as it is examined. The exam paper should be retained in the original package. After returning the item to its package, fold the exam paper, tape it closed (making sure all trace evidence is secure within the bundle) and place it in the package with the item.
- 1.8.1.2.2. Items may be tape lifted to collect evidence. Where tape lifting is not appropriate, tweezing and/or scraping may be substituted. Items involving multiple examination requests shall only be tape lifted or scraped after consultation with analysts from the other disciplines.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 1.8.1.2.3. All collected trace evidence shall be stored with original item unless value is immediately apparent.
- 1.8.1.2.4. Analyst shall document in the notes the presence of hair, fibers, plant material, glass, paint, etc. Such trace evidence shall be reported out only when it is deemed to have value. In those cases where the material appears to be extraneous debris of no significance, the trace statement may be omitted from the report.
- 1.8.1.2.5. The approximate number and quality of hairs shall be noted for hair combings.
- 1.8.1.2.6. In cases where there is other DNA evidence of investigative value that has been tested and profiles obtained, no DNA testing of the collected hair shall be performed without the approval of a Biology Unit Supervisor or Laboratory Manager.
- 1.8.1.2.7. In cases where there is no other DNA evidence of value, the prosecutor/investigator shall be contacted for approval of consuming the hair sample before further analysis of the hair is performed.
- 1.8.1.2.8. When appropriate, examination of the hair collected shall be performed to determine if hair consistent with human origin is present.
- 1.8.1.2.9. Human hairs can be submitted for DNA analysis when beneficial.
- 1.8.1.3. Dried Stains (See Serology flow charts)**
 - 1.8.1.3.1. Visual Inspection – A visual inspection of the item shall be conducted to determine the location, if present, of questioned stains. An ultraviolet light or an alternate light source may be used to help locate stains.
 - 1.8.1.3.2. Stain Identification – If a sample is being retained because of a positive result, (phenolphthalein, acid phosphatase, or confirmatory testing) then amylase testing need not be performed.
 - 1.8.1.3.3. If phenolphthalein is being performed on stains which demonstrated positive luminol result and phenolphthalein is negative, no further testing should be performed due to the possibility of false positives for luminol. These results should be reported out as inconclusive.
- 1.8.1.4. Stain Evaluation – After attempting to identify the stain, the stain shall be evaluated for further testing.**
 - 1.8.1.4.1. If no biological material is identified on the item, no further testing shall be performed, except for instances where touch DNA or handler/wearer analysis is appropriate.
 - 1.8.1.4.2. If the stain is found to be biological but no standards are available for comparison, the stain or a portion thereof shall be retained by the laboratory for future testing. DNA testing may be performed and results entered into the Indiana DNA Database when eligible.
 - 1.8.1.4.3. If the stain is found to be biological material and all necessary standards have been submitted, the analyst shall determine if DNA typing shall be performed based on an evaluation of the stain. Things that may be considered include, but are not limited to, the amount, size, concentration, location and condition of the stain.
- 1.8.1.5. Collection/retention of swabs**
 - 1.8.1.5.1. Each swab retained in a subitem, whether removed from a submitted item or collected by the analyst shall have a unique identifier. Multiple swabs from one

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

area/stain shall be retained together in the subitem. If different testing results are obtained between swabs in the same subitem each result will be reported.

1.8.2. Phenolphthalein (Kastle-Meyer Reagent), Presumptive Test for Blood.

- 1.8.2.1. Principle:** Phenolphthalein is an oxidizable organic molecule, which can be oxidized by free hydroxyl ions liberated by peroxidase-like action. The heme group of hemoglobin possesses a peroxidase-like activity, which may catalyze the breakdown of hydrogen peroxide to form free hydroxyl radicals. Phenolphthalin (reduced form) is oxidized by the free hydroxyl ions to phenolphthalein (oxidized form), producing a pink color.

Phenolphthalein is a presumptive test for the presence of blood. Confirmatory testing shall be performed for conclusive identification. Phenolphthalein has been shown to give false positives or weak reactions with various oxidizing agents, plant material, etc.

1.8.2.2. Procedure

- 1.8.2.2.1. Rub the suspected bloodstain with a piece of filter paper or a cotton swab or make a small cutting of the suspected bloodstain and place on white filter paper or in a white spot plate well.
- 1.8.2.2.2. Add one to three drops of the phenolphthalein working solution to the stain.
- 1.8.2.2.3. Wait 10-15 seconds, assuring no pink color develops at this time.
- 1.8.2.2.4. Add one to three drops of 3% Hydrogen Peroxide.
- 1.8.2.2.5. Upon addition of the Hydrogen Peroxide an immediate pink color is indicative of the possible presence of blood.

- 1.8.2.3.** Reagents shall be tested with positive and negative controls and the results recorded in the case notes. This shall be performed and recorded daily when in use and prior to use on evidence. Lot numbers and/or preparation dates of reagents shall also be recorded.

1.8.3. Luminol, Presumptive Test for Blood.

- 1.8.3.1. Principle:** Luminol is a presumptive test designed to process large areas where stains are not readily visible. Luminol works best on old stains (where the heme group has been converted to hemin) and while it does soak the area tested, it should not interfere with additional testing. In the luminol test, the hemin acts as a catalyst, triggering the oxidation of luminol by hydrogen peroxide in an alkaline solution.

Confirmatory testing shall be performed for conclusive identification. Luminol has been shown to give false positives with certain metal compounds, plant peroxidases and some cleansers, especially cleansers which contain hypochlorite (bleach). Luminol is an alternative method that can be used on phenolphthalein negative items where bloodstains are not easily visible.

1.8.3.2. Procedure

- 1.8.3.2.1. Prepare working solution by combining 10 ml Solution A, 10 ml Solution B, 10 ml Solution C and 70 ml distilled water. Alternatively, using previously prepared spray bottle, fill to marks for each reagent.
- 1.8.3.2.2. All individuals present during testing shall wear gloves, eye protection and a surgical mask or equivalent.
- 1.8.3.2.3. Spray the area of interest in the dark until well-soaked. Luminol's reaction with a true bloodstain produces a luminescent glow, frequently in patterns such as spatters, smears, wipes or drag marks, or even footwear impressions.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

1.8.3.3. Alternate Procedure

- 1.8.3.3.1. Prepare the luminol solution by adding the contents of the powdered luminol tube (8 oz size) to 8 oz (250 ml) of distilled water in a plastic reagent bottle. Alternate powdered luminol tubes are available in 4 oz and 16 oz sizes. If these are used, add the corresponding amount of distilled water, 4 oz (125 ml) or 16 oz (500 ml).
- 1.8.3.3.2. Gently mix the powder and distilled water with a gentle swirling action in order to avoid mixing an excessive amount of air or oxygen into the solution.
- 1.8.3.3.3. Transfer the luminol solution into a fine mist spray bottle. Any unmixed powder remnants should be left in the bottom of the plastic reagent bottle and not transferred into the spray bottle to avoid clogging the sprayer.
- 1.8.3.3.4. The mixed luminol solution should be used within about 20 - 30 minutes.
- 1.8.3.3.5. Follow steps 1.8.3.2.2 and 1.8.3.2.3 as above.

- 1.8.3.4. Any remaining luminol solution cannot be stored for later use because the reagent will lose potency. The remaining luminol solution can be disposed by washing it into the sink with a large quantity of water. Also, be sure to clean out the spray bottle and nozzle with clean water, as any luminol remaining in the sprayer will form a difficult-to-remove clog.
- 1.8.3.5. Reagents shall be tested with positive and negative controls and the results recorded in the case notes. This shall be performed and recorded daily when in use and prior to use on evidence or at a crime scene. Lot numbers and/or preparation dates of reagents shall also be recorded.

1.8.4. Takayama, Confirmatory Test for Blood

- 1.8.4.1. **Principle:** Takayama reacts with the heme portion of the blood to form characteristic hemochromogen microcrystals.

Some vegetable peroxidases may form Takayama crystals similar to those formed by blood; however, these substances do not have the same appearance or physical properties as blood.

1.8.4.2. Procedure

- 1.8.4.2.1. Prepare working solution by combining glucose, sodium hydroxide, pyridine, and distilled water. The working solution may be made up and stored in the refrigerator for up to one month.
- 1.8.4.2.2. Place a small cutting, few threads or flakes on a microscope slide and cover with a cover slip. Alternatively, a drop of stain extract may be dried onto the slide.
- 1.8.4.2.3. Flood under the cover slip with the prepared Takayama reagent.
- 1.8.4.2.4. Gently heat the microscope slide on a hot plate or equivalent heat source. Optionally, if the stain is weak, the test may be allowed to sit at room temperature.
- 1.8.4.2.5. When cutting turns bright pink/red, remove from heat and allow to cool to room temperature before observing under the microscope. Negative samples may never turn to the bright pink color.
- 1.8.4.2.6. Bright red, spiky crystals should be apparent in the presence of a sufficient concentration of blood. Tapping of the cover slip to separate crystals from the cutting may be necessary to observe crystals.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 1.8.4.3.** Reagents shall be tested with positive and negative controls and the results recorded in the case notes. This shall be performed and recorded daily when in use and prior to use on evidence. Lot numbers and/or preparation dates of reagents shall also be recorded.

1.8.5. Species/Human Origin using Ouchterlony Plates

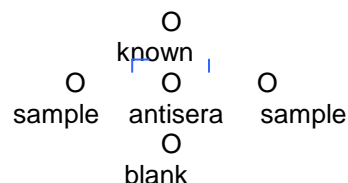
- 1.8.5.1. Principle:** Human anti-serum reacts with proteins in human blood and some tissues to form a visible white precipitate band.

1.8.5.2. Procedure

- 1.8.5.2.1. In previously prepared Ouchterlony plates, cut wells as illustrated in the diagram below. The size of the wells can vary from 2-6 mm in diameter, with about 5 mm between wells. Remove the agar plugs.
- 1.8.5.2.2. In the known well, place either a cutting from a known human bloodstain and fill the well with distilled water; or fill the well with liquid human serum or blood.
- 1.8.5.2.3. In the blank well, place the negative control/background. Distilled water shall be included as a negative control at least once in each series of tests.
- 1.8.5.2.4. In the two sample wells, place a small cutting and fill the well with distilled water. Alternatively, a cutting of the stain can be eluted in a microtube in distilled water. The extract is then placed in the well. While preferable to run in duplicate, limited sample size may require only one test.
- 1.8.5.2.5. In the center well, place the human anti-serum.
- 1.8.5.2.6. Allow to stand overnight at room temperature.
- 1.8.5.2.7. Observe white precipitate bands present for each test, by placing a light beneath the plate.
- 1.8.5.2.8. Alternatively, a small amount of Coomassie blue stain can be poured on the plate, drained, and rinsed off with water or use destain to aid the visualization of bands.
- 1.8.5.2.9. The white precipitate bands shall form a box type configuration to indicate an identity reaction.
- 1.8.5.2.10. Manufacturer's instructions shall be followed in preparation of antisera. Antisera may be aliquoted, frozen, or refrigerated.

1.8.5.3. Procedure for Other Species

- 1.8.5.3.1. In place of known human serum, appropriate animal serum is placed in known well.
- 1.8.5.3.2. Antiserum of the species of interest is placed in the center well.



- 1.8.5.4** Reagents shall be tested with positive and negative controls and the results recorded in the case notes. This shall be performed and recorded daily when in use. Lot numbers and/or preparation dates of reagents shall also be recorded.

1.8.6. Acid Phosphatase, Presumptive Test for Semen

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 1.8.6.1. Principle:** Seminal fluid is typically found to contain acid phosphatase in levels 400 - 1000 times those found in other body fluids. This test uses the ability of acid phosphatase to hydrolyze a phosphate ester substrate to release a free alcohol, which in turn reacts with a diazonium salt to give a brilliantly colored end product.

Acid Phosphatase is a presumptive test for the presence of semen. Confirmatory testing shall be performed for conclusive identification. Possible sources of acid phosphatase other than semen include vaginal secretions, urine, sweat or fecal material.

- 1.8.6.2. Procedure:** Prepare substrate and dye solution immediately prior to testing. These solutions will be stable for 1-2 hours at room temperature. Alternatively, use previously aliquoted and frozen solutions.

- 1.8.6.2.1. Weigh out about 20 µg of alpha naphthyl phosphate and place in shell vial or small test tube.
- 1.8.6.2.2. Weigh out about 20 µg of fast blue or fast red dye (shall be in diazonium salt form) and place in second shell vial or small test tube.
- 1.8.6.2.3. Add about 1 ml of acetate buffer to each and mix.
- 1.8.6.2.4. Cut a small (approximately 2 mm x 2 mm) portion of the stained material and place it on a small piece of filter paper, in a white ceramic spot plate well or in a small test tube. An extract can be used.
- 1.8.6.2.5. Wet the cutting with the alpha naphthyl phosphate solution. Wait about 1 minute.
- 1.8.6.2.6. Add 1-2 drops of the dye solution to the cutting.
- 1.8.6.2.7. The development of color (depending on dye used) in less than 15 seconds is indicative of the presence of acid phosphatase. Color soaked into the filter paper under the sample is also indicative of a positive test.
- 1.8.6.2.8. A slow development of color could be an indication of acid phosphatase from sources other than semen. This may be indicated on the worksheet as a slight color change (SCC).
- 1.8.6.2.9. The interpretation of the results shall be reported by the analyst.

- 1.8.6.3.** Reagents shall be tested with positive and negative controls and the results recorded in the case notes. This shall be performed and recorded daily when in use and prior to use on evidence. Lot numbers and/or preparation dates of reagents shall also be recorded.

1.8.7. Extraction of Body Fluid Stains

- 1.8.7.1. Principle:** Evidentiary stains can be extracted and the extracts used for body fluid stain identification.

1.8.7.2. Procedure:

- 1.8.7.2.1. Prepare samples (and backgrounds, if used) for testing by eluting a cutting of the stain (approximately 3 mm by 3 mm) in an appropriate amount of distilled water in a microcentrifuge tube overnight in the refrigerator. Alternatively the sample can be eluted in a 37°C oven for a minimum of 30 minutes or at room temperature for a minimum of 1 hour.
- 1.8.7.2.2. After incubation, the cutting should be removed, placed into the cap with holes for drainage or a spinex basket, and the extract spun down.

1.8.8. Visual Observation of Spermatozoa

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

1.8.8.1. Principle:

The visual identification of spermatozoa is a scientifically accepted method of positively identifying the presence of seminal material.

1.8.8.2. Procedure:

- 1.8.8.2.1. Place ~10 µl of the previously extracted sample on a microscope slide and cover. Phase contrast microscopy is used to differentiate the cellular appearance. Spermatozoa are round to ovoid with an acrosomal cap, midpiece, and tail. When the tail and midpiece are not present, the distinctive flattened profile of turned spermatozoa should be observed.
- 1.8.8.2.2. Alternatively a small (1 mm x 1 mm) cutting may be eluted directly onto the slide with a drop of distilled water, agitating with forceps. Remove the cutting and cover the extract with a cover slip.
- 1.8.8.2.3. The observations should be rated using the following system:
 - POS (+) Only a few sperm or sperm heads on the entire slide.
 - 1+ One sperm or sperm head per several fields of view.
 - 2+ One sperm or sperm head in about half of all fields of view.
 - 3+ One sperm or sperm head in most fields of view.
 - 4+ Several sperm or sperm heads in most fields of view.

1.8.9. Christmas Tree Stain (Kernechtrot-Picroindigocarmine Differential Stain) (Optional procedure to help visualize spermatozoa)

1.8.9.1. Principle: The Christmas tree stain is used to assist in scanning slides for the presence of spermatozoa. Red and green colored stains are utilized to enhance the appearance of spermatozoa and epithelial cells in biological samples.

1.8.9.2. Procedure

- 1.8.9.2.1. Pipette ~5-10 µl of the pellet from the bottom of extracted sample tube and place onto microscope slide. Previously prepared slides from the evidence collection kit may go directly to heat fix and staining procedures.
- 1.8.9.2.2. Also prepare a slide from a 1:50 dilution of a sperm positive semen stain to use as a positive control for the staining procedure.
- 1.8.9.2.3. Heat fix the sample onto the slide.
- 1.8.9.2.4. After the slide has cooled, place on a level surface and add several drops of the SERI Christmas Tree Stain A (red stain) to the slide. Stain for about 15 minutes.
- 1.8.9.2.5. Rinse stain from the slide by gently running distilled water over the slide.
- 1.8.9.2.6. Return slide to a level surface and add several drops of the SERI Christmas Tree Stain B (green stain) to the slide. Stain for about 10 seconds.
- 1.8.9.2.7. Rinse stain from the slide by gently running 95 to 100% ethanol over the slide.
- 1.8.9.2.8. Allow slide to air dry or dry in 56°C oven. After drying, slide is ready to view microscopically.

1.8.9.3. Interpretation

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

1.8.9.3.1. Spermatozoa will appear as small red/pink structures and have the following staining characteristics:

Acrosomal cap	clear to pink
Post acrosomal cap	dark pink to red
Midpiece	green to blue
Tail	green to blue

1.8.9.3.1.1. Nucleated epithelial cells will appear as green rhomboid-like structures with a red/pink nucleus. The cell's appearance can vary in shape, often being folded or overlapping and are normally larger than the spermatozoa heads.

1.8.9.3.2. **NOTE:** The smear slides contained in evidence collection kits shall be viewed using phase contrast microscopy before proceeding to the Christmas tree stain procedure.

1.8.10 Amylase

1.8.10.1 Principle:

1.8.10.1.1 The detection of amylase in forensic stains is of particular importance to the analysis of cases involving oral intercourse. Performing amylase testing in sexual assault cases will be dependent on other results and the needs of the specific case. Elevated amylase levels may be from oral intercourse or from elevated levels within the vaginal cavity. The amount of amylase on items such as cigarette butts, envelopes, stamps, masks, etc. is not a good indication of the amount of cellular material available for DNA analysis.

1.8.10.1.2 Amylase is an enzyme which is responsible for the hydrolysis of starch (amylose and amylopectin) to glucose and maltose. Amylase is present in high concentrations in saliva, pancreatic fluid, and in fecal material. Limited amylase activity is also present in other body fluids.

1.8.10.2 Procedure

1.8.10.2.1 In previously prepared plates, cut wells, 2-6 mm in diameter, in a circle around the outer edge of the plate (not to exceed 7 wells). One additional well can be cut into the center. Remove the agar plugs.

1.8.10.2.2 In one well, place a minimum of 5 µl of a prepared extract of a known dried saliva stain or a 1:100 dilution of liquid saliva in distilled water.

1.8.10.2.3 In succeeding wells, place the same amount of extracted samples. It is important to use the same volume for knowns and unknowns.

1.8.10.2.4 In the last well, place distilled water or a prepared extract of a blank substrate.

1.8.10.2.5 Incubate at 37°C for 18 to 24 hours.

1.8.10.2.6 Stain with Florence iodine diluted ~1:100.

1.8.10.2.7 Measure area not stained by iodine across the diameter and record.

1.8.10.2.8 A questioned sample should be retained for DNA analysis if the diameter is 70% or greater than the diameter of the known saliva sample. A sample with a result of less than 70% may be retained at analyst's discretion. A clearly defined zone with a diameter greater than the sample well will be a positive result. All other results should be reported as "No amylase detected."

1.8.10.2.9 The interpretation of the results shall be reported by the analyst.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

1.8.10.3 Reagents shall be tested with positive and negative controls and the results recorded in the case notes. This shall be performed and recorded daily when in use. Lot numbers and/or preparation dates of reagents shall also be recorded.

1.8.11 Visual Observation of Human Hair

1.8.11.1 Principle: Before DNA analysis can be performed on hair collected as evidence, a determination of possible human origin and the identification of the root shall be performed.

1.8.11.2 Procedure

1.8.11.2.1 When the questioned hairs are on a tape lift, the lift should be examined using a stereomicroscope to eliminate obvious hair fragments, fibers, and animal hairs. All hairs of possible human origin with sufficient root material should be removed from the lift and placed in a paper bindle. A wet mount should be prepared when further examination is required to determine human origin and/or presence of root material. Questioned hairs are placed on a microscope slide with a drop of distilled water, covered with a cover slip, and examined with a light microscope. The number and general appearance of the human hairs should be noted when practical. If additional hairs/fibers are present in the original package, they should be placed in a separate bindle and retained in the package.

1.8.11.2.2 Observation should begin with the presence of scales (imbricate in humans and some animals). Human hairs demonstrate a wide variety in color and pigment distribution among individuals. The color in the cortex should be fairly uniform throughout the length and breadth of the hair. An exception would be dyed or bleached hairs, which could demonstrate a sudden or gradual color change at the dye line. (Animal guard hairs demonstrate a characteristic color banding). The medulla (the amorphous central core) can be continuous, discontinuous, fragmentary, or not present in human hair. Medullary index should be one-third or less the total diameter of the hair. There is considerable variation in the general appearance of human hairs depending on the body area. In general there is less variation in diameter along the length in human hairs than in animal hairs. The appearance of the root is very important both in determining origin and in determining the area to sample for DNA. The appearance of a large skin tag is not necessarily an indication of success in extraction of DNA.

1.8.11.2.3 Examination documentation shall be of sufficient detail so that an equally qualified analyst is provided enough information in the case notes so as to reach the same conclusion. In the case of hair, when a "human hair" conclusion is reached the notes shall include observations regarding scale type, medulla, coloring/pigment distribution and any other pertinent observations.

1.8.12 Crosslinker Procedure

1.8.12.1 Consumables (pipette tips, microtubes, columns, etc...) may be exposed in the crosslinker for 2 to 15 minutes before use in casework. Time in excess of 15 minutes shall have the approval of the Technical Leader documented in the case record.

1.8.12.2 The use of the crosslinker may reduce the presence of amplifiable DNA.

1.9. Records:

1.9.1 Examination of Sexual Assault kits and Suspect Collection kits shall be recorded on the appropriate worksheets.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 1.9.2 Results of testing of body fluids shall be recorded on the worksheets designed for that purpose, or alternatively be recorded in the case notes within the description of the item as long as all required controls are documented appropriately.
- 1.9.3 All photos and electronically created documentation shall be stored as part of the case record. See [Appendix 7](#) for instructions.
- 1.9.4 The technical review of the case record shall be recorded on the worksheet provided for that purpose.

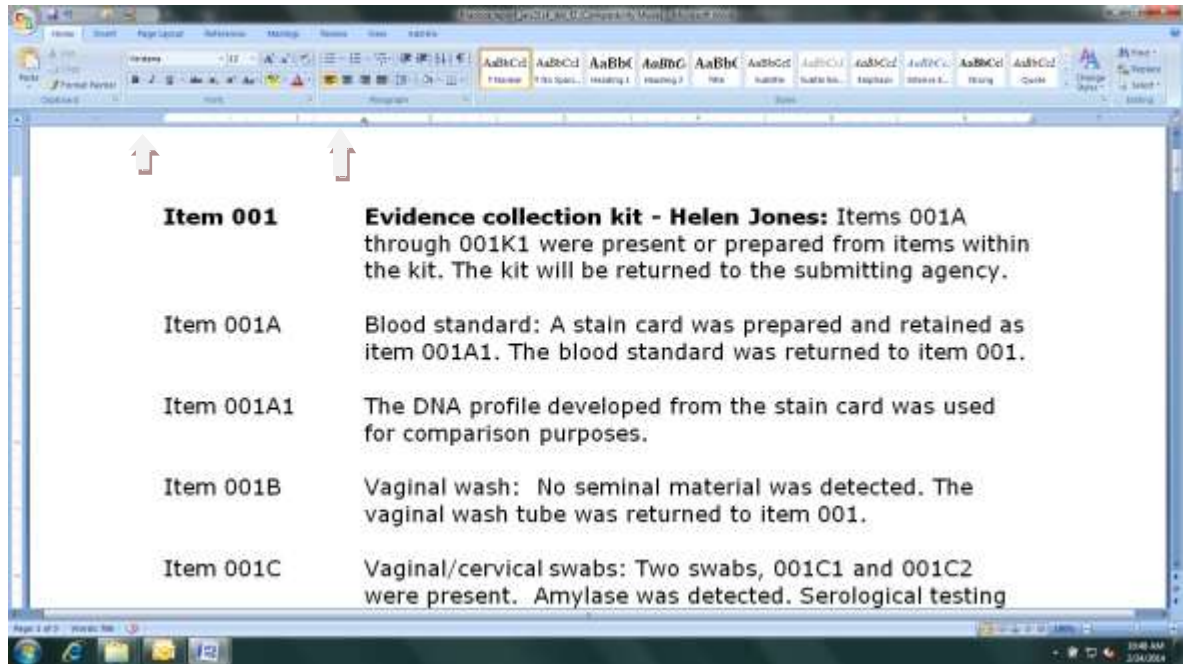
1.10. Interpretations of Results:

- 1.10.1. The quality and quantity of a sample shall determine which tests are performed. Conclusions reached are based on the actual tests performed in each case. See specific tests for interpretation guidelines.
- 1.10.2. The analyst shall report out any identified body fluid stains present and list all items retained for possible DNA analysis in the report.

1.11 Report Writing General Rules for Serological Analysis:

- 1.11.1 Serology results shall be reported prior to any DNA results for each item.
- 1.11.2 Item numbers shall include all leading zeros.
- 1.11.3 Items shall be reported by item in order.
- 1.11.4 The description of each item in the results section shall not include the packaging.
- 1.11.5 Retention statements shall be with the serological results for an item. If no serology results are being reported, the retention statement shall be the last statement of the results paragraph.
- 1.11.6 At a minimum, first and last name of victim(s) and/or suspect(s) shall be used throughout the entire report.
- 1.11.7 The significant contents of an item shall be listed in the report unless accounted for in the item description.
- 1.11.8 Reports shall be typed into a word document with specific formatting
 - 1.11.8.1 A hanging indent shall be used set at 0 and a margin will be used, set at 1.5 (see below)

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



- 1.11.8.2 Original items and their description will be **bolded**. All other information shall be in normal Verdana 12.
- 1.11.9 Similar results with an item may be grouped together. Multiple results from an item/subitem may be reported in order of importance.
- 1.11.10 The number of items retained should be listed with the item (i. e. Four swabs were present or Three samples were retained).
- 1.11.11 The trace paragraph, request for additional standards, pending DNA analysis paragraph and evidence disposition statement shall be after all reported results when appropriate.
- 1.11.12 See [Appendix 5](#) for wording examples.

1.12 References

- 1.12.1 Forensic Science Handbook, ed. Richard Saferstein. 1982. Prentice-Hall. New Jersey.
- 1.12.2 Forensic Science Handbook, Volume I. ed. Richard Saferstein. 2002. Prentice-Hall. New Jersey.
- 1.12.3 Forensic Science Handbook, Volume II. ed. Richard Saferstein. 1988. Prentice-Hall. New Jersey.
- 1.12.4 Forensic Science Handbook, Volume III. ed. Richard Saferstein. 1993. Prentice-Hall. New Jersey.
- 1.12.5 Gaensslen, R.E. 1983. Sourcebook of Forensic Serology, Immunology and Biochemistry. United States Government Printing Office, Washington D.C.
- 1.12.6 Jungreis, Ervin. 1997. Spot Testing Analysis. John Wiley & Sons, New York.
- 1.12.7 Laux, D. L. 1992. Detection of bloodstains; A Training Manual. Richfield Ohio.
- 1.12.8 Jeyendran, R. S. 2000. Interpretation of Semen Analysis Results, a Practical Guide. Press Syndicate of the University of Cambridge, Cambridge, United Kingdom.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 1.12.9 Deedrick, D. W. and Koch, S. L. Microscopy of Hair, Part 1: A Practical Guide and Manual for Human Hairs. *Forensic Science Communications*. January 2004. Volume 6(1).
- 1.12.10 Deedrick, D. W. and Koch, S. L. Microscopy of Hair, Part 2: A Practical Guide and Manual for Animal Hairs. *Forensic Science Communications*. July 2004. Volume 6(3).
- 1.12.11 Practical Aspects of Rape Investigation: A Multi Disciplinary Approach. Third Edition. eds. Robert R. Hazelwood and Ann Wolbert Burgess. Elsevier, New York.
- 1.12.12 Saferstein, R. 1995. Criminalistics, An Introduction to Forensic Science. Fifth Edition. Prentice Hall, New Jersey.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

2.0 DNA METHODS:

2.1 Scope:

This test method is designed for the guidance of Laboratory personnel who assist investigations where the specificity of DNA testing is needed. Evidence amenable to DNA testing includes blood, seminal fluid, saliva, bone, tissue and hair. This manual may be expanded or altered as new techniques and/or genetic systems are found applicable.

2.1.1 The DNA is first extracted from the biological sample, quantified, amplified to produce many fluorescently tagged copies of specific regions of the DNA and finally processed to separate and detect a DNA profile(s). The analyst compares the DNA profile identified in the sample with the DNA profile from a known standard from an individual to determine similarities or dissimilarities. In addition, the analyst may provide an estimate of occurrence of the genetic profile in the population.

2.1.2 Return of Evidence

2.1.2.1 Stain cards from whole blood samples, cuttings from body fluid stains, DNA extracts, and other selected DNA evidence shall be retained by the laboratory for any possible future testing. For amplified DNA see 2.8.1.2.7.

2.1.2.2 The retained items may be released at the prosecutor's request. The request shall be documented in the case record. A valid court order shall circumvent this procedure.

2.2 Precautions/Limitations:

2.2.1. Evidence

2.2.1.1 Liquid items such as blood standards shall be refrigerated.

2.2.1.2 Stains which are still moist shall be air dried in a secure area before submission to the Laboratory.

2.2.1.3 Clean paper or cardboard containers shall be used to package dried evidence. Plastic containers shall not be used for packaging because they hold moisture which often leads to putrefaction of biological materials. Exceptions to this rule would include blood tubes, body tissue samples and condoms.

2.2.1.4 Specific examinations performed on items for DNA analysis shall be determined by laboratory personnel.

2.3 Related Information:

2.3.1 Worksheet Manual

2.3.2 [Appendix 2](#) Assumed Two Person Mixture Interpretation

2.3.3 [Appendix 3](#) Assumed Three Person Mixture Interpretation

2.3.4 [Appendix 4](#) Statistical Analysis for Autosomal STR Testing

2.4 Instruments:

2.4.1 Applied Biosystems® 3500 Genetic Analyzer Capillary Electrophoresis Instrument – Simultaneously separates and detects multiple amplified DNA samples by size by capillary electrophoresis using fluorescent tagged primers.

2.4.2 Applied Biosystems® 7500 Real Time PCR System – Measures accumulation of amplification product over time to determine total DNA present by the use of a fluorescent reporter molecule.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.4.3** Autoclave - An instrument that uses heat and steam to sterilize solutions, contaminated equipment and waste.
- 2.4.4** Balance - An analytical balance used for preparation of analytical reagents and buffers.
- 2.4.5** BIOMEK NX^P Automation Platform – Robotic liquid handling system.
- 2.4.6** BIOMEK 3000 Automation Platform – Robotic liquid handling system.
- 2.4.7** Centrifuges - A microcentrifuge capable of operating at greater than 15,000 rcf and a clinical serofuge capable of operating at a maximum of 3,400 rpm; used for the purification of DNA in evidence samples and the separation of solid components from liquids, respectively.
- 2.4.8** Crosslinker - Preprogrammed ultraviolet exposure is factory set to 120,000 microjoules per cm². Preset ultraviolet time exposure is factory set to 2 minutes.
- 2.4.9** Laminar Flow Hood – An air purifying biohazard cabinet that maintains a nominal inflow velocity of 80 fpm which prevents contaminants from entering or escaping the work area.
- 2.4.10** Maxwell[®] 16 – Robotic extraction system.
- 2.4.11** Microscope - A light microscope with magnification up to 400X, a stereoscope for general screening of items, and a phase contrast microscope for the identification of spermatozoa.
- 2.4.12** Miscellaneous Laboratory Equipment - Supportive laboratory equipment consisting of ovens, incubators, rotators, pipettors, water baths, stirring/heating plates, vortex mixers, visible/UV light boxes, microwave, thermometers, temperature verification system, vacuum pump, refrigerators/freezers for storing of reagents, buffers and evidence.
- 2.4.13** pH Meter – An instrument capable of manual or automatic temperature compensation and reading +/- 0.01 pH units. Used for preparation of buffers and reagents.
- 2.4.14** Thermal cycler - An instrument that can be programmed to rapidly cycle between high and low temperatures. This process is used to make many fluorescently tagged copies of specific regions on a DNA strand(s).
- 2.4.15** Water Purification System - An apparatus that routes water through a series of filtering devices to produce high quality, uncontaminated water used in buffer preparation and DNA typing methods.
- 2.5 Reagents/Materials: See Reagent Preparation Manual for instructions and logs where appropriate.** Reagents critical to the DNA analysis process are listed in the Critical Reagent Manual.
- 2.5.1** Digest/Wash Buffer
- 2.5.2** DTT 0.39M
- 2.5.3** DTT 1M
- 2.5.4** EDTA 0.5M
- 2.5.5** Nuclease Free Water (NFH₂O)
- 2.5.6** Proteinase K (Pro K) 10 mg/ml
- 2.5.7** Proteinase K (Pro K) 18 mg/ml
- 2.5.8** Sarkosyl 20% w/v
- 2.5.9** SDS 20% w/v
- 2.5.10** Stain Extraction Buffer Stock Solution
- 2.5.11** Stain Extraction Buffer with DTT
- 2.5.12** Stain Extraction Buffer for Automation
- 2.5.13** TE⁻⁴
- 2.5.14** TRIS/EDTA/NaCl Solution

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

2.5.15 TRIS-HCl pH 7.5, 1M

2.5.16 TRIS-HCl pH 8.0, 1M

2.6 Hazards/Safety:

- 2.6.1. All chemicals shall be handled in a safe method as referenced in the specific Safety Data Sheets (SDS).
- 2.6.2. The addition of phenol/chloroform/isoamyl alcohol during extraction, vortexing of the extracts, and transfer to Microcons® shall be done in a chemical fume hood.
- 2.6.3. The manual preparation of samples for electrophoresis by the addition of Hi-Di™ formamide shall be confined to a chemical fume hood. **Caution:** Formamide is an irritant and teratogen; therefore universal precautions and a fume hood shall be utilized when manually working with formamide to avoid inhalation and contact with the skin.
- 2.6.4. The manual handling of lysis buffer should be confined to a chemical fume hood.
- 2.6.5. Universal Precautions shall be in use whenever biological materials are being handled.
- 2.6.6. Extreme caution shall be used when handling liquid body fluid samples.
- 2.6.7. Biological waste shall be disposed of in the appropriate waste receptacle.

2.7 Reference Materials/Controls/Calibration Checks:

- 2.7.1. The accuracy and specificity of test results are ensured by running known DNA controls and reagent controls at the same time as evidence samples. See the specific test for the appropriate controls to be run and the interpretation of the results.

2.8 Procedures/Instructions

2.8.1 Examination Procedure

2.8.1.1 Standards for Comparison

- 2.8.1.1.1. Appropriate standards, preferably whole blood or buccal swabs, from individuals involved, should be submitted along with the questioned materials.
- 2.8.1.1.2. Whole blood standards should be submitted in a purple top tube that contains ethylene-diamine-tetra-acetic acid (EDTA). This tube shall be refrigerated.
- 2.8.1.1.3. Alternately a swabbing taken from the inside cheek of an individual may be collected, dried, and placed in a sealed envelope to be used as a standard.
- 2.8.1.1.4. When supplied, a secondary standard shall be clearly marked as such and treated as a standard.

2.8.1.2 DNA Analysis

- 2.8.1.2.1. All extracts are considered work product. Any remaining extract shall be returned to the appropriate subitem after sealing in a zip-lock bag or plastic sleeve, keeping different samples separated by heat sealing, or in separate bags for long term storage. Extraction controls shall also be retained in separate compartments or bags within the subitem(s).
- 2.8.1.2.2. If more than one swab from an area/stain has been retained the analyst must indicate whether a single swab, multiple swabs or a combined sample of two or more swabs are being analyzed in the case notes. Combined samples shall be tracked in the case notes by a unique identifier.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.8.1.2.3 When multiple samples have been retained from one item, the analyst can limit the number of samples per item to be extracted. A representative sample shall be tested initially. On an initial examination, 5 samples per piece of clothing or bedding should be sufficient to be extracted. Additional samples may be extracted as necessary. In sexual assault cases, where samples indicating penetration are available, additional samples are at analyst discretion. Samples where spermatozoa were detected and rated 1+ or above shall be extracted using the differential procedure. All samples AP+ or sperm positive may be extracted with a differential procedure at the analyst's discretion.
- 2.8.1.2.3.1 Acid phosphatase positive samples need not be extracted where there are extracted samples in which spermatozoa were present. Additional samples can be extracted at analyst's discretion.
- 2.8.1.2.3.2 If no spermatozoa were detected in a case and all samples retained for sexual assault only demonstrate the presence of acid phosphatase then a differential extraction procedure may be used at the analyst's discretion.
- 2.8.1.2.4 A quantification procedure shall be performed to estimate the quantity of extracted DNA.
- 2.8.1.2.5 If sufficient, a portion of the extracted DNA shall be amplified.
- 2.8.1.2.6 In order to be used in a comparison with evidentiary samples, any standard (primary or secondary) shall demonstrate a single source profile. Any exception to this rule shall only be made with the approval of the Technical Leader and documented in the case record.
- 2.8.1.2.7 A portion of the amplified DNA is removed and used in the typing method. The remaining amplified DNA, considered work product, shall be destroyed after the case has been administratively reviewed.
- 2.8.1.2.8 The amount of sample available for testing, the recoverability of DNA from the sample, and the quality of the DNA shall affect which tests are performed. The conclusions reached are based upon the analysis performed.

2.8.1.3 General Rules:

- 2.8.1.3.1 If one cutting has a quantity of DNA that would require concentration and another cutting from the same item has an appropriate quantity for analysis without additional treatment; it shall be left to the analyst's discretion as to whether or not both samples, or just the one sample will be typed.
- 2.8.1.3.2 Multiple reagent blanks (RB) may be extracted as part of a sample batch. Any samples proceeding for additional testing such as Y-STR analysis should have more than one reagent blank. All reagent blanks shall at a minimum be carried through quantification. Amplification shall be performed on the reagent blank demonstrating the highest quantification value. One reagent blank may be reserved without additional treatment to be used with those samples in the batch not requiring additional treatment. A batch is defined as all samples before a reagent blank(s) with no intervening reagent blanks.
- 2.8.1.3.3 Any additional treatment to a sample shall be done to the corresponding reagent blank. This would include but not be limited to additional Microcon® purifications, use of Centri-sep columns, amplifying more than 5µl, or

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

increased injection parameters. Reagent blanks shall not be diluted unless performed during the Biomek robotic processing of samples.

- 2.8.1.3.4 The extraction of question samples and known samples shall be performed separately (separated by time and/or space). This shall include a separate reagent blank for known and questioned samples and, when practical, use of separate extraction worksheets or separate columns of the same extraction worksheet.
- 2.8.1.3.5 Extraction and typing of background samples is often not beneficial, and is therefore not required, but may be done at the discretion of the DNA analyst to aid in the interpretation of case sample results. If a background sample is extracted it shall be typed if DNA was detected during the quantification step. The background sample shall be concentrated only if the sample it is the background for is concentrated.

2.8.2 Crosslinker Procedure

- 2.8.2.1 Consumables (pipette tips, microtubes, columns, etc...) may be exposed in the crosslinker for 2 to 15 minutes before use in casework. Time in excess of 15 minutes shall have the approval of the Technical Leader documented in the case record.
- 2.8.2.2 The use of the crosslinker may reduce the presence of amplifiable DNA.

2.8.3 Sampling Protocols

- 2.8.3.1 Sample size may vary from indicated values depending on many factors including but not limited to total sample available and serology test results.
- 2.8.3.2 The analyst shall consume only as much of the available sample as is needed. Normally not more than half of the available sample will be used for testing. If it is necessary to consume an entire sample in testing or an amount such that the remaining portion is insufficient for additional testing, the analyst shall first receive permission from the prosecutor or investigator and document such in the case record. This may be done at the time of submission.

2.8.3.3 Sampling for Regular Extraction

- 2.8.3.3.1 **Blood:** Sample approximately 3 X 3 mm from a blood stain or 3 µl of whole blood.
- 2.8.3.3.2 **Envelope:** Sample approximately 1 X 1 cm of a gummed envelope flap or stamp. Cut sample into smaller pieces before placing in extraction tube. Alternatively, may swab gummed area or wash with three 50 µl rinses and place each rinse into the extraction tube.
- 2.8.3.3.3 **Cigarette:** Sample ½ to all of paper approximately 5 mm down from end or ½ of the paper and filter approximately 5 mm down (Filter not to be used when extracting with Maxwell Robot). Cut sample into smaller pieces before placing in extraction tube.
- 2.8.3.3.4 **Epithelial Swabs:** Sample from 1/3 to entire swab used to collect epithelial cells. May extract two swabs in two separate extraction tubes, combining at step 2.8.6.2. The volume of the associated RB(s) should also be doubled.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

2.8.3.3.5 **Hair:** Rinse root end of hair in 100% ethanol and then dH₂O before sampling 1 cm of root end. If desired a second 1 cm of hair may be extracted separately as a sample blank.

2.8.3.3.6 **Tissue:**

2.8.3.3.6.1 Cut a piece of tissue approximately 3 X 3 mm.

2.8.3.3.6.2 If tissue is immersed in liquid nitrogen, it shall also be crushed into a fine powder. Transfer powder or (if not crushed) tissue sample to a microcentrifuge tube.

2.8.3.3.6.3 Larger samples than indicated may be used, as needed, with the amounts of stain extraction buffer with DTT and Pro K increased proportionally.

2.8.3.4 Sampling for Semen (Differential Extraction)

2.8.3.4.1 **Swabs:** Sample from ¼ to an entire swab. If multiple swabs have been collected together, analysts may sample a portion of each swab and combine into one extraction tube.

2.8.3.4.2 **Clothing:** Sample approximately a 5 X 5 mm cutting.

2.8.3.4.3 **Smear Slides:** Use a moistened swab and swab entire smear, including underside of coverslip. Sample swab as above.

2.8.3.4.4 **Vaginal Wash:** Spin down vaginal wash and collect pellet on one or more swabs. Sample swab(s) as above. Alternatively may pipette ~ ½ of pellet (not to exceed 50 µl) into 1.5 ml extraction tube prior to collecting remaining pellet on swab(s).

2.8.3.5 Bone and Teeth

2.8.3.5.1 Sample cleaning/preparation methods (e.g., scraping, heating, etc.) that best address the variability of sample quality may be used as necessary.

2.8.3.5.2 Remove and separate any soft tissue adhering to sample with a sterilized scalpel or sanding wheel.

2.8.3.5.3 Immerse and agitate at least 1 cubic inch of bone in cold distilled water or a 1:10 bleach solution.

2.8.3.5.3.1 A small brush or toothbrush may be used to gently remove any dirt/debris from the outer surfaces and exposed inner surfaces of sample.

2.8.3.5.3.2 Small bone samples with difficult-to-reach surfaces may be cleaned by sealing the sample in a 50 ml conical tube containing distilled water or a 1:10 bleach solution, then vortexing briefly, changing out the solution, and repeating as necessary.

2.8.3.5.3.3 If necessary, the specimen can be further cleaned by immersion in ethanol and ethyl ether for about 15 minutes each.

2.8.3.5.4 Rinse sample in distilled water and allow the sample to dry.

2.8.3.5.5 Pulverize sample into a fine powder by manual mechanical crushing or by use of a freezer/mill. Bone samples may require multiple freezing/crushing steps. Larger samples (e.g., bones and adult teeth) may need to be initially reduced in size to accommodate the method of pulverization. This may be accomplished by

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

use of a hammer, handsaw, or Dremel® tool. Note: any medical/dental /restorative work on a bone or tooth sample shall be removed prior to pulverization.

2.8.3.5.5.1 Manual Mechanical Crushing with Tissue Pulverizer

2.8.3.5.5.1.1 Larger samples may initially need to be reduced to ~0.5 in. fragments or smaller to accommodate the physical size of the pulverizer.

2.8.3.5.5.1.2 Crush bone sample using the pulverizer and mallet. Optionally, sample may be immersed in liquid nitrogen for ~1–10 minutes to aid in crushing.

2.8.3.5.5.2 SPEX SamplePrep® 6770 Freezer/Mill

2.8.3.5.5.2.1 Sample must initially be reduced to ~0.25 in. fragments (width of a pencil eraser) or smaller to accommodate the requirements of the mill. Larger fragments will decrease pulverization efficiency and may damage the mill.

2.8.3.5.5.2.2 Insert a sterilized blunt end cap into a sterilized grinding cylinder.

2.8.3.5.5.2.3 Add the sample to the cylinder. Do not add sample in excess of 1/3 total volume of the cylinder.

2.8.3.5.5.2.4 Insert a steel impactor into the cylinder and seal the cylinder with a sterilized flanged end cap.

2.8.3.5.5.2.5 Slowly add liquid nitrogen to the freezer/mill until it reaches the fill mark. An initial amount of liquid nitrogen will quickly boil off as the tank cools. When the liquid settles, add additional liquid nitrogen up to the fill mark. Initial cooling of the instrument will consume ~4–5 L of liquid nitrogen, and each sample pulverization will require an additional ~1 L liquid nitrogen.

2.8.3.5.5.2.5.1 Always handle liquid nitrogen containers or any item exposed to liquid nitrogen (including grinding cylinders) with cryogenic gloves.

2.8.3.5.5.2.6 Load assembled sample vial into the freezer/mill chamber (blunt end first). Optionally, up to two additional samples may also be prepared in vials and placed in the pre-cooling chamber above the freezer/mill chamber.

2.8.3.5.5.2.7 Close the freezer/mill and pulverize the sample using the following protocol: Cycles: 4, Pre-cooling: 10 min, Run: 2 min, Cool: 2 min, CPS (cycles per second): 10. Regularly check the control panel on the freezer/mill to ensure that sufficient liquid nitrogen is remaining in the tank. If “LOW LN LEVEL” is displayed, pause the protocol by pressing “PAUSE”, open the freezer/mill, and add liquid nitrogen to the fill mark, then close the freezer/mill and resume the protocol.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.8.3.5.5.2.8 When the program is complete, open freezer/mill and remove vial from freezer/mill chamber. To conserve liquid nitrogen, any subsequent samples should be immediately loaded into the mill and pulverized as described above. If additional samples were loaded in the pre-cooling chamber during the initial sample run, they may be pulverized with the following protocol (omitting the pre-cooling phase): Cycles: 4, Pre-cooling: 0 min, Run: 2 min, Cool: 2 min, CPS: 10.
- 2.8.3.5.5.2.9 Allow vial to warm up for ~5–10 minutes before using the cap extractor tool to open the vial. If the sample was “sticky” or “tacky” prior to pulverization, it may be necessary to open the vial earlier to aid removal. Transfer the contents of the vial into a sterilized weigh boat and separate the impactor from the sample. A sterilized spatula may be used to aid sample removal.
- 2.8.3.5.6 Transfer the pulverized sample into one or more microcentrifuge tubes. Manual mechanical crushing typically generates small sample fragments accompanied by some powder, while a freezer/mill typically converts an entire sample to a very fine powder. Typically, 1 adult tooth with root (or similarly sized bone sample), or 1 g of bone, will generate fragments/powder to fill two 1.5 ml microcentrifuge tubes about halfway full, leaving sufficient space for extraction reagents.
- 2.8.3.5.7 Larger samples than indicated may be used, as needed, with the amounts of stain extraction buffer with DTT and Pro K increased proportionally.

2.8.4 Regular Organic Extraction With Microcon® Concentration Of All Sample Types Including Blood, Hair, Tissue, And Bone. (Microcon® 100 or Fast Flow)

- 2.8.4.1 Place the sample in 1.5 ml microcentrifuge tube. Each group of samples being extracted shall include a reagent blank as the last sample in the batch.
- 2.8.4.2 To the sample add 300 µl of stain extraction buffer with DTT and 7.5 µl Proteinase K (Pro K) solution (10 mg/ml). Vortex and spin briefly in a microcentrifuge or tap the tube to force the cutting into the extraction fluid. Analyst may increase the amounts of stain extraction buffer with DTT and Pro K proportionally for larger samples. The same treatment shall be performed to any associated reagent blanks.
- 2.8.4.3 Incubate the tube at 56°C overnight (18 hours minimum/24 hours maximum). An extraction time of no less than 2 hours may be used for standards (blood or buccal swabs). A shortened extraction time may only be used with the approval of the Technical Leader (documented in case record) for any other sample types.
- 2.8.4.4 Spin briefly in a microcentrifuge to force the condensate into the bottom of the tube. (For hairs, bones, or tissue it may be preferable to transfer supernatant to a clean microcentrifuge tube before proceeding to 2.8.4.7).
- 2.8.4.5 Using a wooden applicator stick, remove the cutting and proceed to 2.8.4.7 or
- 2.8.4.6 Transfer the cutting into a spin basket insert. Place the basket insert into the tube containing the stain extract. Spin in a microcentrifuge at approximately 14,000 rcf (relative centrifugal force) for about 5 minutes. Remove and discard the basket insert.
- 2.8.4.7 In a fume hood, add 300 µl of phenol/chloroform/isoamyl alcohol (p/c/i) to the stain extract and vortex the mixture at low speed (in the fume hood) to attain a milky emulsion.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

Spin in a microcentrifuge until completely separated (for at least 3 minutes) at approximately 14,000 rcf. Multiple p/c/i extractions may be performed to further clean up an extract if desired. If larger volumes are used in step 2.8.4.2, equivalent volumes of p/c/i shall be used. The same treatment shall be performed to any associated reagent blanks.

2.8.4.8 See 2.8.6 for Microcon® procedure.

2.8.5 Differential Organic Extraction With Microcon® Concentration Of Semen Stains (Microcon® 100 or Fast Flow)

2.8.5.1 Place the sample in 1.5 ml microcentrifuge tube. Each group of samples being extracted shall include reagent blanks (sperm and non-sperm fraction) as the last samples in the batch.

2.8.5.2 To the sample add:

400 µl Tris/EDTA/NaCl

25 µl 20% Sarkosyl

75 µl NFH₂O

5 µl Pro K (10 mg/ml)

2.8.5.3 Vortex and spin briefly in a microcentrifuge or tap the tube to force the cutting into the extraction fluid.

2.8.5.4 Incubate at 37°C for 2 hours.

2.8.5.5 Spin briefly in a microcentrifuge to force the condensate into the bottom of the tube.

2.8.5.6 Using a wooden applicator stick, remove the cutting and spin in a microcentrifuge for about 5 minutes at approximately 14,000 rcf.

2.8.5.7 Alternately transfer the cutting into a spin basket insert. Place the basket insert into the tube containing the stain extract. Spin in a microcentrifuge at approximately 14,000 rcf for about 5 minutes. Remove and discard the basket insert.

2.8.5.8 While being very careful to not disturb any pelleted material, remove the supernatant fluid from the extract and place it into a new, labeled tube. This supernatant is the non-sperm cell fraction. Analysis of the non-sperm cell fraction resumes at 2.8.5.15. The pellet remaining in the tube is the sperm cell pellet.

2.8.5.9 Wash the sperm cell pellet by resuspending it in 500 µl digest/wash buffer, vortexing the suspension briefly, and spinning the tube in a microcentrifuge at approximately 14,000 rcf for about 5 minutes. Remove and discard the supernatant fluid, being careful not to disturb the cell pellet.

2.8.5.10 Repeat 2.8.5.9 four additional times for a total of five washes of the sperm cell pellet. Approval, documented in the case record, from the Technical Leader is required to use less than the five washes.

2.8.5.11 To the tube containing the washed pellet add:

150 µl Tris/EDTA/NaCl

50 µl 20% Sarkosyl

150 µl NFH₂O

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

10 µl Pro K (10 mg/ml)

40 µl 0.39M DTT

- 2.8.5.12** Close the tube cap, vortex and spin briefly in a microcentrifuge to force all fluid and material to the bottom of the tube.
- 2.8.5.13** Incubate at 37°C for 2 hours.
- 2.8.5.14** Spin briefly in a microcentrifuge to force the condensate into the bottom of the tube.
- 2.8.5.15** In the fume hood, add 400 µl phenol/chloroform/isoamyl alcohol (p/c/i) to both the tube containing the sperm cell pellet and to the tube containing the non sperm fraction. Vortex the mixture briefly at low speed (in the fume hood) to attain a milky emulsion. Spin in a microcentrifuge until completely separated (for at least 3 minutes) at approximately 14,000 rcf. Multiple p/c/i extractions may be performed to further clean up an extract if desired. The same treatment shall be performed to any associated reagent blanks.
- 2.8.5.16** See 2.8.6 for Microcon® procedure.

2.8.6 Microcon® Concentration Of Extracted DNA (Microcon® 100 or Fast Flow)

- 2.8.6.1** To a Microcon® Concentrator add 100 µl TE⁻⁴.
- 2.8.6.2** For Microcon® concentration immediately after organic extraction, transfer the aqueous phase (top layer) to the concentrator in the fume hood. Avoid pipetting organic solvent from the tube into the concentrator. For Microcon® concentration of other DNA extracts, transfer the extract to the concentrator
- 2.8.6.3** Close the cap on the concentrator and spin in a microcentrifuge at 500 rcf for at least 10 minutes. (Microcon® 100 may be spun up to 1,200 rcf).
- 2.8.6.4** Optional Step: Carefully remove the concentrator unit from the assembly and discard the fluid from the filtrate cup. Return the concentrator to the top of the filtrate cup.
- 2.8.6.5** Remove the cap and add 200 µl nuclease free water (NFW₂O) or TE⁻⁴ to the concentrator. Replace the cap and spin the assembly in a microcentrifuge at 500 rcf for at least 10 minutes. (Microcon® 100 may be spun up to 1,200 rcf).
- 2.8.6.6** Remove the cap and add a measured volume of NFW₂O or TE⁻⁴ (40 µl is the recommended amount however, varied amounts can be added in some circumstances) to the concentrator. Remove the concentrator from the filtrate cup and carefully invert the concentrator into a new, labeled retentate cup. Discard the filtrate cup.
- 2.8.6.7** Spin the Fast Flow in a microcentrifuge at 1,000 rcf for at least 3 minutes. The Microcon® 100 should be spun 500-1,200 rcf for at least 5 minutes.
- 2.8.6.8** Discard the concentrator. If desired, the sample can be brought up with additional water by adding it to the retentate cup. Cap the retentate cup.
- 2.8.6.9** Extracts can be stored refrigerated or frozen prior to quantification/amplification. Prior to use after storage the samples shall be vortexed and spun briefly in a microcentrifuge.
- 2.8.6.10** Multiple Microcon® concentration steps may be performed to further clean up or concentrate any extract. The same treatment shall be performed on the associated reagent blank (or a portion of) for each sample batch.

2.8.7 Centri-sep Clean-Up Of Extracts

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.8.7.1** Clean-up of extracts with Centri-sep columns may be performed at any time. The same treatment shall be performed on the associated reagent blank (or a portion of) for each sample batch.
- 2.8.7.2** Remove the top column cap and reconstitute the column by adding 800 µl of nuclease free water (NFW₂O). Leave the column end stopper in place so the column can stand up by itself. Replace the column cap and hydrate the gel by shaking and inverting the column or vortexing briefly.
- 2.8.7.3** Allow the column to hydrate for at least 30 minutes at room temperature. Reconstituted columns may be refrigerated at 4°C overnight. Allow to warm up to room temperature before proceeding.
- 2.8.7.4** Remove the air bubbles from the column gel by inverting the column and sharply tapping the column, allowing the gel to slurry to the opposite end of the column. Stand the column up and allow the gel to settle while in a microtube rack.
- 2.8.7.5** First remove the column cap, and then remove the column end stopper from the bottom.
- 2.8.7.6** Allow the excess column fluid to drain into a wash tube (2 ml). If the fluid does not begin to flow immediately through the column apply gentle pressure to the top of the column to force the fluid to start through the column filter. This can be accomplished by snapping the cap on briefly. Discard this fluid.
- 2.8.7.7** Spin the column and wash tube at 750 rcf for 2 minutes. **NOTE: It is important to keep track of the position on the column using the orientation mark molded into the column.**
- 2.8.7.8** Optionally: discard eluate and rinse column with 150-200µl NFW₂O and spin for 2 minutes at 750 rcf.
- 2.8.7.9** Blot any drop at the end of the column. Discard the wash tube. Do not allow the gel material to dry excessively.
- 2.8.7.10** Transfer the sample extract to the top of the column, without disturbing the gel surface. Keep track of amount of sample added to column (less than 50 µl is recommended).
- 2.8.7.11** Place the column into the sample collection tube (1.5 ml) and place both into the rotor. **Maintain proper column orientation.** The highest point of the gel media in the column should always point toward the outside of the rotor. Spin the column and the collection tube at 750 rcf for 2 minutes.
- 2.8.7.12** Discard the spin column and cap the sample collection tube.
- 2.8.7.13** Extracts can be stored refrigerated or frozen prior to quantification/amplification. Prior to use after storage, the samples shall be vortexed and spun briefly in a microcentrifuge.

2.8.8 Maxwell®16 Protocol

2.8.8.1 Maxwell®16 Preparation of Samples For Any Cellular Material (except bone):

- 2.8.8.1.1** For each sample, combine 350 µl Incubation Buffer with 10 µl Pro K (18 mg/ml) and 40 µl DTT (1M). Alternatively, Stain Extraction Buffer for Automation (SEBA) may be substituted for Incubation Buffer. *Example: for 16 samples, combine 5,600 µl Incubation Buffer (or SEBA) with 160 µl Pro K and 640 µl DTT.*
- 2.8.8.1.2** Place sample at the bottom in a 1.5 ml microcentrifuge tube. Each group of samples being extracted shall include a reagent blank as the last sample in the batch.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.8.8.1.3 To the sample add 400 µl Buffer/Pro K/DTT Master Mix. Vortex and spin briefly in a microcentrifuge or tap the tube to force the cutting into the extraction fluid.
- 2.8.8.1.4 Incubate the samples at 56°C for 1 hour.
- 2.8.8.1.5 Spin briefly in a microcentrifuge to force the condensate into the bottom of the tube. (For hairs it may be preferable to transfer supernatant to a clean microcentrifuge tube before proceeding).
- 2.8.8.1.6 Add 200 µl of Lysis Buffer to each sample.
- 2.8.8.1.7 Vortex samples briefly and spin down.
- 2.8.8.1.8 Using a wooden applicator stick, remove the cutting and proceed to 2.8.8.1.10 or
- 2.8.8.1.9 Transfer the cutting into a spin basket insert. Place the basket insert into the tube containing the stain extract. *Optionally, the Lysis Buffer may also be transferred to the spin basket.* Spin in a microcentrifuge at approximately 14,000 rcf for about 5 minutes. Remove and discard the basket insert.
- 2.8.8.1.10 Save the extract until ready for automated DNA extraction. Do not refrigerate or freeze sample. Leave processed sample at room temperature (~22-25°C) overnight, if necessary.
- 2.8.8.1.11 Proceed to 2.8.8.3 for Maxwell® 16 automated extraction.

2.8.8.2 Maxwell®16 Preparation of Samples For Differential Extractions:

- 2.8.8.2.1 For each sample, combine 400 µl Tris/EDTA/NaCl, 10 µl 20% Sarkosyl, 90 µl NFH₂O and 5 µl Proteinase K (10 mg/ml).
- 2.8.8.2.2 Place the sample in 1.5 ml microcentrifuge tube. Each group of samples being extracted shall include reagent blanks (sperm and non-sperm fraction) as the last samples in the batch.
- 2.8.8.2.3 To the sample add 505 µl of the Master Mix. Vortex and spin briefly in a microcentrifuge or tap the tube to force the cutting into the extraction fluid.
- 2.8.8.2.4 Incubate the sample at 37°C for 2 hours.
- 2.8.8.2.5 Spin briefly in a microcentrifuge to force the condensate into the bottom of the tube.
- 2.8.8.2.6 Using a wooden applicator stick, remove the cutting and spin in a microcentrifuge for about 5 minutes at approximately 14,000 rcf.
- 2.8.8.2.7 Alternately transfer the cutting into a spin basket insert. Place the basket insert into the tube containing the stain extract. Spin in a microcentrifuge at approximately 14,000 rcf for about 5 minutes. Remove and discard the basket insert.
- 2.8.8.2.8 While being very careful to not disturb any pelleted material, remove the supernatant fluid from the extract and place it into a new, labeled tube. This supernatant is the non-sperm cell fraction. Analysis of the non-sperm cell fraction resumes at 2.8.8.2.11. The pellet remaining in the tube is the sperm cell pellet.
- 2.8.8.2.9 Wash the sperm cell pellet by resuspending it in 500 µl digest/wash buffer, vortexing the suspension briefly, and spinning the tube in a microcentrifuge at approximately 14,000 rcf for about 5 minutes. Remove and discard the supernatant fluid, being careful not to disturb the cell pellet.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

2.8.8.2.10 Repeat step 2.8.8.2.9 four times for a total of five washes of the sperm cell pellet. Approval, documented in the case record, from the Technical Leader is required to use less than the five washes.

2.8.8.2.11 Lysis buffer step

2.8.8.2.11.1 For each sample pair (sperm and non-sperm fraction) combine 600 µl of Lysis Buffer with 6 µl of 1M DTT.

2.8.8.2.11.2 Add 400 µl of the Lysis Buffer master mix to each sperm fraction sample and 200 µl to each non-sperm fraction sample.

2.8.8.2.12 Vortex sample and spin down briefly.

2.8.8.2.13 Save until ready for automated DNA extraction. Do not refrigerate or freeze sample. Leave processed sample at room temperature (~22-25°C) overnight, if necessary.

2.8.8.2.14 Proceed to 2.8.8.3 for Maxwell® 16 automated extraction.

2.8.8.3 Maxwell® 16 Instrument Automated DNA Purification

2.8.8.3.1 Place the number of cartridges to be used into the cartridge preparation rack. Each cartridge corresponds to one sample. Place each cartridge into the rack. Hold the cartridge firmly and remove the seal.

2.8.8.3.2 Place one plunger into well #8 of each cartridge.

2.8.8.3.3 Transfer the entire sample into well #1.

2.8.8.3.4 Place 0.5 ml elution tubes (properly labeled) into the elution tube slot. Add 50 µl of Elution Buffer.

2.8.8.3.5 Turn on the Maxwell® 16 Instrument. Verify LEV and FNCS modes are displayed.

2.8.8.3.6 Scroll to “Run” on the Menu screen and press the “Run/Stop” button.

2.8.8.3.7 Open the door when prompted to do so on the LCD display. Press the “Run/Stop” button to extend the platform.

2.8.8.3.8 Place the cartridge rack into the Maxwell® 16 Instrument.

2.8.8.3.9 Press the “Run/Stop” button. The platform will retract. Close the door.

2.8.8.3.10 Upon method completion, open the instrument door. The plungers should be located in Well #8 at the end of the run. Check to make sure that all of the plungers have been removed from the magnetic rod assembly. If the plungers have not been removed, push them down gently by hand and remove them from the magnetic rod assembly.

2.8.8.3.11 Press the “Run/Stop” button to extend the platform.

2.8.8.3.12 Remove the Elution Tubes from the heated elution tube slots, as soon as possible and close the top on each tube. (Leaving the heated elution tubes in the instrument for an extended period of time can result in evaporation of the sample.) Samples can be stored at 4°C or frozen. Prior to use after storage, the samples shall be vortexed briefly and spun in a centrifuge for about 5 seconds.

2.8.8.3.13 Remove cartridges and plungers from the instrument platform and discard.

2.8.8.3.14 When completed, clean the Maxwell® 16 Instrument and cartridge rack with 70% ethanol and turn off machine.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

2.8.9 Real-Time PCR Quantification Using Quantifiler® Duo

2.8.9.1 Create a Plate Document (Note: The plate document shall be created and saved on the computer prior to running the quantification plate on the instrument.)

2.8.9.1.1 Turn on the computer.

2.8.9.1.2 Turn on the Real-Time PCR instrument (must be on prior to opening the software).

2.8.9.1.3 Open the Applied Biosystems 7500 System Sequence Detection Software v 1.2.3.

2.8.9.1.4 Set up the Plate Document as described below: File ⇒ New

New Document Wizard

Define Document
Select the assay, container, and template for the document, and enter the operator name and comments.

Assay : Absolute Quantification (Standard Curve) [v]
Container : 96-Well Clear [v]
Template : Blank Document [v]
Browse ...
Operator : AB
Comments : SDS v1.2.3
Default Plate Name : Plate1

< Back Next > Finish Cancel

Assay: **Absolute Quantification (Standard Curve)**
Container: **96-Well Clear**
Template: Quantifiler® Duo
Operator: your name
Plate Name: "First case on plate_date_plate#" ex. "00A1234_01Jan11_01"

Click **Finish**.

2.8.9.1.5 Sample names and case numbers can be entered into each well at this time or it can be done after the run has completed. Each sample shall be uniquely identified.

2.8.9.1.6 Save the plate document at this time.

2.8.9.1.7 Leave the plate document open.

2.8.9.2 Preparation Of The Quantification Plate

2.8.9.2.1 The Quantifiler® Duo kit should be stored at -15 to -25 °C upon receipt. Once thawed, all components are to be stored at 2 to 8 °C.

2.8.9.2.2 The Quantifiler® Duo PCR Primer Mix and the Quantifiler® Duo PCR Reaction Mix shall be protected from excessive exposure to light.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

2.8.9.2.3 The preparation of the standard curve and the plate shall be performed in the PCR amplification set-up area.

2.8.9.2.4 The standard curve is stable for up to 2 weeks at 2 to 8°C when prepared using Quantifiler® Duo Dilution Buffer.

2.8.9.2.5 Prepare the Standard Curve

2.8.9.2.5.1 Allow the entire Quantifiler® Duo kit to thaw prior to first use.

2.8.9.2.5.2 Label eight microcentrifuge tubes Std. 1 through Std. 8.

2.8.9.2.5.3 Dispense the required amount of Quantifiler® Duo dilution buffer to each tube. (See table below for examples)

2.8.9.2.5.4 Vortex the Quantifiler® Duo DNA Standard [200 ng/μl stock] for 3 to 5 seconds.

2.8.9.2.5.5 Add the calculated amount of Quantifiler® Duo DNA Standard to Std. 1 and mix thoroughly.

2.8.9.2.5.6 Using a new pipette tip, add the calculated amount of Std. 1 to Std. 2 and mix thoroughly.

2.8.9.2.5.7 Using a new pipette tip each time, continue diluting each successive concentration until the dilution series is complete.

Standard Curve	Dilution Series Minimum Amount	Dilution Series Example Amount	Dilution Factor
Std. 1 [50.0 ng/μl]	30 μl dilution buffer + 10 μl of 200 ng/μl DNA stock	90 μl dilution buffer + 30 μl of 200 ng/μl DNA stock	4X
Std. 2 [16.7 ng/μl]	20 μl dilution buffer + 10 μl Std. 1	60 μl dilution buffer + 30 μl Std. 1	3X
Std. 3 [5.56 ng/μl]	20 μl dilution buffer + 10 μl Std. 2	60 μl dilution buffer + 30 μl Std. 2	3X
Std. 4 [1.85 ng/μl]	20 μl dilution buffer + 10 μl Std. 3	60 μl dilution buffer + 30 μl Std. 3	3X
Std. 5 [0.620 ng/μl]	20 μl dilution buffer + 10 μl Std. 4	60 μl dilution buffer + 30 μl Std. 4	3X
Std. 6 [0.210 ng/μl]	20 μl dilution buffer + 10 μl Std. 5	60 μl dilution buffer + 30 μl Std. 5	3X
Std. 7 [0.068 ng/μl]	20 μl dilution buffer + 10 μl Std. 6	60 μl dilution buffer + 30 μl Std. 6	3X
Std. 8 [0.023 ng/μl]	20 μl dilution buffer + 10 μl Std. 7	60 μl dilution buffer + 30 μl std. 7	3X

2.8.9.3 Prepare the Reactions

2.8.9.3.1 Each plate shall contain a standard curve series run in duplicate and a Non-Template Control (NTC).

2.8.9.3.2 Determine the number of samples to be quantified, including standards and the non-template control. Add 3 to 5 reactions to this number to compensate for the loss that occurs during reagent transfers.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.8.9.3.3 Using the Master Mix worksheet, calculate the required amount of each component of the master mix. Multiply the volume per reaction (µl) by the total number of reactions.

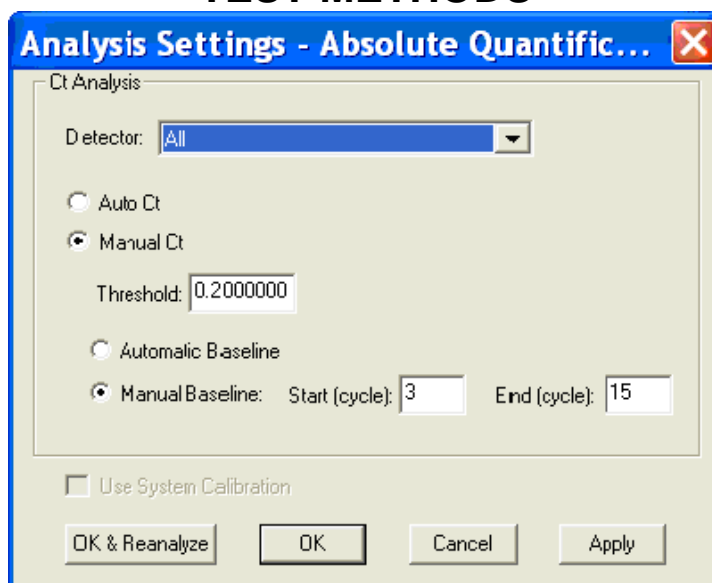
PCR Master Mix Component	Volume per Reaction (µl)
Quantifiler® Duo Primer Mix	10.5
Quantifiler® Duo PCR Reaction Mix	12.5
Total Volume	23.0

- 2.8.9.3.4 Vortex the Primer Mix 3 to 5 seconds, then centrifuge briefly.
- 2.8.9.3.5 Swirl the PCR Reaction Mix gently before using. **Do not vortex.**
- 2.8.9.3.6 Pipette the required volumes of each component into a microcentrifuge tube.
- 2.8.9.3.7 Vortex the Master Mix 3 to 5 seconds, then centrifuge briefly.
- 2.8.9.3.8 Dispense 23 µl of the Master Mix into each reaction well of a 96-well optical plate.
- 2.8.9.3.9 Add 2 µl of sample, standard, or non-template control (water or dilution buffer) to the appropriate wells.
- 2.8.9.3.10 Seal the reaction plate with an Optical Adhesive Cover. Run the edge of the cover applicator between the rows and columns of the wells to ensure that all wells are sealed properly.
- 2.8.9.3.11 Spin the plate using either a centrifuge or a salad spinner to remove any bubbles and force samples into the bottom of each well.
- 2.8.9.3.12 Place the plate in the instrument.
- 2.8.9.3.13 Select the **Instrument** tab of the plate document and click “Start”.
- 2.8.9.3.14 When the run is finished, click “Okay”.

2.8.9.4 Analyze The Plate

- 2.8.9.4.1 Verify the analysis settings as displayed below: **Analysis** ⇒ **Analysis Settings**.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



2.8.9.4.2 Analyze the plate by clicking the Green Arrow (►) on the toolbar or select **Analysis ⇒ Analyze**.

2.8.9.4.3 Select the **Results** tab

2.8.9.4.3.1 At this point, there are several sub-tabs to view/verify data (**Standard Curve; Amplification Plot; Report; etc.**).

2.8.9.4.3.2 To view results for all wells: select all wells of the plate document by clicking on the small box left of column 1 and above row A.

2.8.9.4.3.3 If you make any changes after analyzing the plate (i.e. omit a well; change a standard to unknown), you must re-analyze the plate again as described in 2.8.9.4.2.

2.8.9.4.4 Examine the Human and Male standard curves. (See Interpretation Guidelines for Real-time PCR Quantification for additional evaluation of the standard curves.)

2.8.9.4.5 Check for inhibition of samples by looking at the C_T values for the IPC.

2.8.9.4.6 Save data under each associated laboratory case number and request folder located in the analysts' folders on the server.

2.8.9.4.7 At a minimum the required documents for the case record shall be generated. The required documents include the plate document displaying quantification values, the plate document displaying C_T values, the Duo Human standard curve graph, and the Duo Male standard curve graph if the evidence is from a sexual assault or if the amount of male DNA will be used for any sample evaluation.

2.8.9.5 Interpretation Guidelines For Real-Time PCR Quantification

2.8.9.5.1 Controls

2.8.9.5.1.1 **Standard Curve:** The purpose of the standard curve is to evaluate the quality of the results from the quantification standard reactions.

2.8.9.5.1.1.1 **Slope:** indicates the PCR amplification efficiency for the assay. The acceptable slope range is -3.0 to -3.6 with a slope of -3.3 indicating 100% amplification efficiency. Scientific rounding rules apply. The analyst shall

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

obtain documented Technical Leader approval to use data when the slope is outside the accepted range.

- 2.8.9.5.1.1.2 **Y-intercept:** indicates the expected C_T value for a sample with Quantity = 1 (i.e. 1 ng/ μ l). The acceptable range is between 28 and 31. If the value is < 28, the target amount of DNA for amplification may need to be increased. The analyst shall obtain documented Technical Leader approval to use data when the Y-intercept value is <28.
- 2.8.9.5.1.1.3 **R² value:** a measure of the closeness of fit between the standard curve regression line and the individual C_T data points of the quantification standard reactions. A value of 1.00 indicates a perfect fit between the regression line and the data points. This value shall be ≥ 0.980 . If the R² value is <0.98 the test is inconclusive and should be repeated. The Technical Leader shall be notified with documentation in the case record.
- 2.8.9.5.1.2 **Internal PCR Control (IPC):** The purpose of the IPC is to distinguish between a true negative sample result and reactions affected by the presence of PCR inhibitors, assay setup, and a chemistry or instrument failure.

Duo Human (VIC) and/or Duo Male (FAM)	IPC (NED)	Interpretation	Suggestions / Options
No amplification	Amplification	True negative (No human DNA detected)	No further analysis of sample
No amplification	No amplification	Invalid result	Re-Microcon® and/or Centri-sep; Re-extract; or dilute and re-quantify
Amplification (low C_T)	No amplification or High C_T	Inconclusive IPC result	Make dilutions and re-quantify (optional)
Amplification (high C_T)	No amplification or High C_T	Partial PCR Inhibition	Re-Microcon® and/or Centri-sep; Re-extract; or dilute and re-quantify

- 2.8.9.5.1.2.1 A low C_T value of < 20 for VIC is an indication of competition between the human-specific and IPC PCR reactions due to very high concentrations of the human template DNA. An analyst should make dilutions of the sample and run on another real-time PCR plate.
- 2.8.9.5.1.2.2 A high C_T value of >30 for the IPC (NED) is an indication of an inhibitor in the sample. An analyst may choose to re-Microcon® and/or Centri-sep the sample prior to amplification and typing of the sample. The C_T value for the IPC should range from 20 to 30.
- 2.8.9.5.1.2.3 A profile can sometimes be obtained from a sample in which the IPC is undetected. It is at the discretion of the analyst whether or not to continue processing a sample in which the IPC is undetected. If the sample is not

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

carried throughout the testing process, it shall be reported out as inconclusive.

- 2.8.9.5.1.3 **Non-Template Control (NTC):** Contains PCR reagent, but no template DNA. Occasionally, a value may be given for the NTC due to background fluorescence. The analyst may proceed with amplification and typing of the samples using caution with interpretation of any profiles obtained from the samples.
- 2.8.9.5.1.4 Occasionally there will be an outlier on the amplification plot of the standard curve. Up to 2 points may be omitted from the Human curve by changing the task assignment for VIC from "standard" to "unknown" in the Well Inspector. (Or "omit well" if point is to be dropped from both standard curves.) Be sure to reanalyze the plate to incorporate the changes. The analyst shall need documented supervisor approval to omit additional points in the standard curve. The Technical Leader shall be notified with documentation in the case record.
- 2.8.9.5.1.5 At the lowest concentration point of the Male standard curve, there are only ~3 to 4 copies of the haploid target locus per μl . Because of stochastic effects when using the lowest concentration point, the CT values are more variable and may affect the closeness of fit (R^2 value) between the standard curve regression line and the individual points of the standard curve. For this reason, one or both std. 8 points may be omitted from analysis. Up to 2 additional points may be omitted from the Male standard curve. Be sure to reanalyze the plate to incorporate the changes. The analyst shall need documented supervisor approval to omit additional points in the standard curve. The Technical Leader shall be notified with documentation in the case record.
- 2.8.9.5.1.6 If the ratio of female to male DNA in a single sample exceeds 25:1 in instances where it is necessary to identify a possible male contributor, no autosomal STR analysis of that sample shall be performed and Y-STR analysis is recommended. Non-sperm cell fractions where the sperm cell fraction is being analyzed shall be amplified regardless of the amount of male DNA present. If the ratio of female to male DNA in a single sample exceeds 10:1, the relative value should be weighed. Y-STR or other analysis may be considered in this situation. If sufficient sample is available, autosomal STR analysis may be attempted. Note: the female DNA contribution is determined by subtracting the quantity of male DNA from the quantity of human DNA. (human-male:male). In samples where the human DNA value approaches 0.01ng/ μl , the male quantitation value (and ratio of female to male) may no longer be accurate and autosomal STRs may be considered at the analyst's discretion.
- 2.8.9.5.1.7 Dynamic range: If the quantity of Human DNA detected in the sample is below 0.01ng/ μl no additional autosomal STR analysis of that sample shall be performed. When the quantity of Human DNA detected is between 0.023 and 0.01ng/ μl the sample need not be amplified if usable results are obtained from other samples.
- 2.8.9.5.1.8 Dynamic range: The analyst should make a reasonable effort to target an amount of DNA during extraction not to exceed 50 ng/ μl . If the sample is > 50 ng/ μl , dilutions shall be made and re-quantified if they are to be amplified.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

2.8.9.5.2 Quantification values from the Human target (VIC) shall be used for amplification of STR's.

2.8.9.5.3 Because the quantification values may have many significant figures, the analyst may truncate the value to one digit past the decimal point, but only after the value has been multiplied by 5 for amplification. (i.e. 1A = 1.59 ng/μl x 5 μl = 7.95 ng/5 μl = 7.9).

2.8.10 Powerplex® Hot Start (HS) 16 Introduction (Applied Biosystems 3500 Genetic Analyzer)

2.8.10.1 The Promega PowerPlex® 16 HS System allows for the amplification of fifteen short tandem repeat (STR) loci and the Amelogenin locus found on the X and Y chromosome (see chart on next page). The amplification occurs in a single reaction tube and detection occurs by a single capillary electrophoresis injection. The overlapping loci can be visualized simultaneously by using PCR primers labeled with four different fluorescent tags (see chart on next page).

2.8.10.2 The Applied Biosystems 3500 Genetic Analyzer utilizes electrokinetic injection of DNA molecules into polymer-filled capillaries which separates the DNA fragments by size. The fluorescent tag labeled primers incorporated into the PowerPlex® 16 HS amplification products, are responsive to the frequency of the 20mW solid state laser. Upon excitation, the fluorophores are raised to a higher energy level. When the fluorophores return to their normal energy level, a fluorescent signal is emitted. This signal is then detected by a camera within the 3500 capillary electrophoresis instrument which converts the signal to a computer image where it is visualized in an electropherogram as a peak.

2.8.10.3 The data produced by the 3500 Genetic Analyzer is analyzed with GeneMapper® ID-X Software which results in peaks labeled with their allele designation. The allele designation for each sample is accomplished through the use of an internal lane standard (ILS). The ILS is injected with each sample and it contains 22 fragments of known length. The ILS determines the base pair size of the fragments in the sample and the software compares the sizes to an allelic ladder to determine the allele designation.

The PowerPlex® 16 HS System Locus-Specific and Allelic Ladder Information

Locus	Chromosomal Location	Repeat Sequence ¹ 5'-->3'	Allelic Ladder Size Ranges ^{3,4} (bases)	STR Ladder Alleles ⁵ (# of repeats)	Fluorophore
Penta E	15q	AAAGA*	379-474	5-24	Fluorescein
D18S51	18q21.3	AGAA*	290-366	8-10, 10.2, 11-13, 13.2, 14-27	Fluorescein
D21S11	21q11-21q21	TCTA*	203-259	24, 24.2, 25, 25.2, 26-28, 28.2, 29, 29.2, 30, 30.2, 31, 31.2, 32, 32.2, 33, 33.2, 34, 34.2, 35, 35.2, 36-38	Fluorescein
TH01	11p15.5	AATG*	156-195	4-9, 9.3, 10-11, 13.3	Fluorescein

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

D3S1358	3p	TCTA*	115-147	12-20	Fluorescein
FGA	4q28	TTTC*	322-444	16-18, 18.2, 19, 19.2, 20, 20.2, 21, 21.2, 22, 22.2, 23, 23.2, 24, 24.2, 25, 25.2, 26-30, 31.2, 43.2, 44.2, 45.2, 46.2	TMR
TPOX	2p23-2pter	AATG*	262-290	6-13	TMR
D8S1179	8q	TCTA*	203-247	7-18	TMR
vWA	12p12-pter	TCTA*	123-171	10-22	TMR
Amelogenin ²	Xp22.1-22.3 and Y	NA	106(X)/112(Y)	X,Y	TMR
Penta D	21q	AAAGA*	376-449	2.2, 3.2, 5, 7-17	JOE
CSF1PO	5q33.3-34	AGAT*	321-357	6-15	JOE
D16S539	16q24-qter	GATA*	264-304	5,8-15	JOE
D7S820	7q11.21-22	GATA*	215-247	6-14	JOE
D13S317	13q22-q31	TATC*	176-208	7-15	JOE
D5S818	5q23.3-32	AGAT*	119-155	7-16	JOE

¹ The August 1997 report (25, 26) of the DNA Commission of the International Society for Forensic Haemogenetics (ISFH) states, "1) for STR loci within coding genes, the coding strand shall be used and the repeat sequence motif defined using the first possible 5' nucleotide of a repeat motif; and 2) for STR loci not associated with a coding gene, the first database entry or original literature description shall be used".

² Amelogenin is not an STR but displays a 106-base, X-specific band and a 112-base, Y-specific band. 9947A DNA (female) displays only the 106-base, X-specific band.

³ The length of each allele in the allelic ladder has been confirmed by sequence analyses.

⁴ When using an internal lane standard, such as the Internal Lane Standard 600, the calculated sizes of allelic ladder components may differ from those listed. This occurs because different sequences in allelic ladder and ILS components may cause differences in migration. The dye label also affects migration of alleles.

⁵ For a current list of microvariants, see the Variant Allele Report published at the U.S. National Institute of Standards and Technology (NIST) web site at: www.cstl.nist.gov/div831/strbase/

2.8.11 PowerPlex® 16 HS Amplification Set-Up

- 2.8.11.1** The following steps shall be performed in the PCR amplification set-up area.
- 2.8.11.2** Thaw the Amplification Grade Water, PowerPlex® HS 5X Master Mix, and PowerPlex® 16 HS 10X Primer Pair Mix. When thawed, it is important to vortex the PowerPlex® 16 HS 5X Master Mix and PowerPlex® 16 HS 10X Primer Pair Mix tubes for 5 to 10 seconds. (Do not centrifuge after vortexing as this may cause the primers/dNTPs to be concentrated at the bottom of the tube.) The Amplification Grade Water may be stored at 2-10° C for extended periods.
- 2.8.11.3** Determine the number of samples to be amplified, including controls (reagent blank, positive control and amplification blank). Add 2 to 4 reactions to this number to compensate for the loss that occurs during reagent transfer.
- 2.8.11.4** Place one 0.2 ml reaction tube for the Model 9700 Thermal Cycler for each sample into a rack and label appropriately. A 96-well plate can also be used if using the robotic workstation.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.8.11.5** 1.0 to 2.0 ng of template DNA is recommended for the amplification. Amplification of greater than 2.0 ng of template DNA may result in increased artifacts and interfere with interpretation. Targeting less than 1.0 ng of template DNA should be used only with samples whose concentration falls between 0.01 ng/μl and 0.057 ng/μl. Such samples shall be interpreted with caution. Samples with concentrations greater than 0.057 ng/μl shall target between 1.0 ng to 2.0 ng for amplification.
- 2.8.11.6** Using the PP16HS Amplification Worksheet (5 μl template DNA), calculate the required amount of each component of the PCR master mix. Multiply the volume (μl) per sample by the total number of reactions to obtain the final volume (μl).
- 2.8.11.6.1** Components of Master Mix/sample:
- 12.5 μl Nuclease Free or Amplification Grade Water
 - 5 μl PowerPlex® HS 5X Master Mix
 - 2.5 μl PowerPlex® 16 HS 10X Primer Pair Mix
 - 20 μl Total Volume (w/o sample)
- 2.8.11.7** Add the calculated volume of each component to a 1.5 ml tube. Mix gently.
- 2.8.11.8** Add 20 μl of PCR master mix to each sample tube or well using a positive displacement pipettor or a repeat pipettor.
- 2.8.11.9** Pipette 5 μl of each sample into the respective tube or well containing master mix.
- 2.8.11.10** For samples requiring more than 5 μl of sample volume, use the variable PP16HS Amplification Worksheet to calculate the required amount of each component of the PCR master mix. Sample volumes above 5 μl shall be subtracted from the nuclease free or amplification grade water volume in the master mix.
- 2.8.11.10.1** Components of the Master Mix/sample:
- Up to 12.5 μl Nuclease Free or Amplification Grade Water
 - 5 μl PowerPlex® HS 5X Master Mix
 - 2.5 μl PowerPlex® HS 10X Primer Pair Mix
 - Between 7.5 and 20 μl Total Volume (w/o sample)
- 2.8.11.11** Add the calculated volume of each component to a 1.5 ml tube. Mix gently.
- 2.8.11.12** Add up to 20 μl of PCR master mix to each sample tube or well using a positive displacement pipettor or a repeat pipettor.
- 2.8.11.13** Pipette the appropriate amount of each sample (up to 17.5 μl) into the respective tube or well containing master mix. For organic extractions if the template DNA is stored in TE buffer, the volume of the DNA sample added should not exceed 20% of the final reaction volume. PCR amplification efficiency and quality can be greatly altered by changes in pH (due to added Tris-HCl) or available magnesium concentration (due to chelation by EDTA). DNA samples stored (or diluted) in NFH₂O are not subject to this caution, but may contain other PCR inhibitors at low concentrations depending on the source of the template DNA and the extraction procedure employed.
- 2.8.11.14** For the positive control, dilute the 2800M or other approved positive DNA standard supplied with the PowerPlex® 16 HS kit to 0.2 - 0.4 ng/μl and record the final

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

concentration on the Amplification Set-up worksheet. Pipette 5.0 µl (1.0 to 2.0 ng) of diluted DNA into a microcentrifuge reaction tube or well containing 20 µl of PCR master mix. A positive control shall be included in each thermal cycler. (NOTE: The positive control should be stored at 2-10°C).

- 2.8.11.15** For the negative amplification control, pipette 5µl of nuclease free or amplification grade water into a microcentrifuge reaction tube or well containing 20µl of the PCR master mix. A negative amplification control shall be included in each thermal cycler.

2.8.12 PowerPlex® 16 HS Amplification

- 2.8.12.1** Assemble the tubes or place the 96-well plate in a thermal cycler.

- 2.8.12.2** Select and run the appropriate thermal cycling protocol.

- 2.8.12.3 Applied Biosystems GeneAmp® 9700 Thermal Cycler**

96°C for 2 minutes, then:

Ramp 100% to 94°C for 30 seconds

Ramp 29% to 60°C for 30 seconds

Ramp 23% to 70°C for 45 seconds

for **10 cycles**, then:

Ramp 100% to 90°C for 30 seconds

Ramp 29% to 60°C for 30 seconds

Ramp 23% to 70°C for 45 seconds

for **20 cycles**, then:

60°C for 30 minutes, then:

Soak at 4°C until the tubes are removed

- 2.8.12.4** When programming the GeneAmp® PCR System 9700 thermal cycler, use the ramping mode for the GeneAmp® PCR System 9600 thermal cycler.

- 2.8.12.5** Select 25 µl for the volume in the amp tubes or wells.

- 2.8.12.6** Remove samples after the amplification process is completed.

- 2.8.12.7** Store the amplified samples in the freezer or refrigerator (if they are to be used within 2 days).

2.8.13 Applied Biosystems 3500 Genetic Analyzer - Data Collection Software version 2.0 - Instrument (only necessary the first time PowerPlex® 16 HS samples are run or if the parameters change.)

- 2.8.13.1** Configure the Security Settings

2.8.13.1.1 Navigate to Tools and select "Security".

2.8.13.1.2 Change Screen settings to those depicted below.

Security Screen:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

The screenshot shows the 'Account Setup' page in the ASB System Administration interface. The page is divided into three main sections: User Name, Password, and Security Policies. The User Name section includes a text box for the user name, a label indicating the length must be between 8 and 32 characters, and radio buttons for spacing (Leading, Trailing, Consecutive). Below this is a checkbox for 'Define name characteristics' and a list of character sets: Alpha, Numeric, Uppercase, Lowercase, and Special. The Password section has a similar text box, a label for length (8-32 characters), radio buttons for spacing, a checkbox for 'Define password characteristics', and the same list of character sets. A note states 'User may not reuse the previous 5 passwords.' The Security Policies section contains three sub-sections: Password Expiration (with radio buttons for 'Yes' and 'No', and a 'Notify the user' checkbox), Account Inactivation (with radio buttons for 'Yes' and 'No', a 'For the last' dropdown set to '24 Hours', and checkboxes for 'If user is already failing' and 'Notify user'), and Session Timeout (with radio buttons for 'Yes' and 'No', a 'For' dropdown set to '30 minutes', and a note '(Not continuous use is not considered user activity)'). At the bottom of the page are buttons for 'Setup Messaging Notifications' and 'Use Defaults'.

2.8.13.1.3 Click “Save Settings” button.

2.8.13.2 Edit User Roles

2.8.13.2.1 Click the “Users” button in the left navigation pane.

2.8.13.2.2 Click the “Roles” tab.

2.8.13.2.3 Set preferences to those depicted below.

2.8.13.2.4 Select “Scientist” and click “Edit”.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Scientist User Role:

Edit Role

Instruction
Enter the name and description for your role, then select the permission(s) to assign to this role. When you are done select the "Save Role" button.
* = Required

1. Define New Role

* Role Name:

Description:

2. Select Permission(s)

- ☒ Select All Permissions
 - ☒ Setup
 - ☒ Create Plate/Plate Template
 - ☒ Run
 - ☐ Edit Default Instrument Run Name
 - ☒ Manage Injection List
 - ☒ Duplicate Injection
 - ☒ Re-Inject
 - ☒ Primary Analysis
 - ☒ Edit Samples
 - ☐ Export Sequencing Results
 - ☐ Assays
 - ☐ Filename Conventions
 - ☐ Results Group
 - ☐ Instrument Protocol
 - ☐ PA Protocol
 - ☐ SA Protocol
 - ☐ QC Protocol
 - ☐ Size Standard
 - ☒ Plates and Plate Templates
 - ☒ Edit Plate and Plate Template
 - ☒ Delete Plate and Plate Template
 - ☒ Import Plate and Plate Template
 - ☒ Export Plate and Plate Template
 - ☐ Dye Sets
 - ☐ Locking

Close **Save Role**

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Edit Role

Instruction

Enter the name and description for your role, then select the permission(s) to assign to this role. When you are done select the "Save Role" button.
* = Required

1. Define New Role

* Role Name:

Description:

2. Select Permission(s)

- ☒ Locking
- ☒ Preferences
 - ☒ Edit System Preferences
 - ☐ Export System Preferences
 - ☐ Import System Preferences
 - ☐ Export User Preferences(All)
- ☒ Calibrations
 - ☒ Perform Spatial Calibration Run
 - ☒ Perform Spectral Calibration
- ☒ Performance Check
 - ☒ Running Performance Check Install Standards
- ☒ Archiving
 - ☒ Archive Datastore Objects
 - ☒ Purge Datastore Objects
 - ☒ Restore Datastore Objects
- ☐ SAE Configuration

2.8.13.2.5 Click "Save Role".

2.8.13.3 Create User Accounts

2.8.13.3.1 Click on the "Users" tab.

2.8.13.3.2 Click "Create" to access a New User window.

2.8.13.3.3 Enter a unique User Name (ex. jdoe8251), set "Password" to lowercase "password" and re-enter. Enter user's first and last name and change settings to those depicted below. Ensure the "User Role" is either set as an "Administrator" or "Scientist".

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

New User Window:

The screenshot shows a web-based form titled "New User:" with a sub-header "Setup a User". The form contains several input fields and options:

- * User Name:** Text field with placeholder "first initial, last name, PE#".
- * Password:** Text field with masked characters (dots).
- * Re-Enter Password:** Text field with masked characters (dots).
- * First Name:** Text field with value "Jane".
- * User Role:** Dropdown menu with "Scientist" selected.
- * Dx User:** Checkbox, currently unchecked.
- Email:** Text field.
- Comments:** Large text area.
- Created By Admin On:** Text field.
- Last Updated On:** Text field.
- Pre-expired:** Checked checkbox.
- Password Expires On:** Text field.
- MI:** Text field.
- * Last Name:** Text field with value "Doe".
- * Status:** Dropdown menu with "Active" selected.
- Electronic Signature:** Radio buttons for "Enable" and "Disable", with "Disable" selected.
- Phone:** Text field.

At the bottom of the form are two buttons: "Close" on the left and "Save" on the right.

2.8.13.3.4 Click the "Save" button.

2.8.13.3.5 Repeat the above steps to create a User Account for each analyst.

2.8.13.4 Manage Audit Settings

2.8.13.4.1 Navigate to Tools and Select "Audit".

2.8.13.4.2 Turn Auditing off by ensuring the "Disable Audit" is grayed out and the "Enable Audit" appears black as depicted below.

2.8.13.4.3 Audit settings may be altered depending on current need.

Disable Audit Settings:



2.8.13.5.2 Turn E-Signature off by ensuring that the “Disable E-Sig” is grayed out and that the “Enable E-sig” is black as depicted below.

2.8.13.5.3 E-Signature settings may be altered depending on need.

[illegible]

2.8.13.6.1 Navigate to the library and select “Instrument Protocols”.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 2.8.13.6.2 Select "Create".
- 2.8.13.6.3 Select "HID" for the Application Type.
- 2.8.13.6.4 Select "36" for the Capillary Length.
- 2.8.13.6.5 Select "POP4" for the Polymer.
- 2.8.13.6.6 Select "F" for the Dye Set.
- 2.8.13.6.7 Select "HID36_POP4" for the Run Module.
- 2.8.13.6.8 Enter the desired Injection Time and Injection Voltage.
- 2.8.13.6.9 Change the run time to 1500 seconds.
- 2.8.13.6.10 Name the protocol with the kit name and the injection voltage and time (ex.PP16HS_3kV3s).

2.8.13.6.10.1 Instrument protocols shall be created for 3kV3s, 3kV8s.

Instrument Protocol:

Setup an Instrument Protocol

Application Type: Capillary Length: cm Polymer:

Dye Set:

Instrument Protocol Properties

* Run Module:

* Protocol Name: ☐ Locked

Description:

Oven Temperature (°C): Run Voltage (kVolts): PreRun Voltage (kVolts): Injection Voltage (kVolts):

Run Time (sec.): PreRun Time (sec.): Injection Time (sec.): Data Delay (sec.):

Advanced Options

Close Save

- 2.8.13.6.11 Click the "Save" button.

2.8.13.7 Create a Size Standard

- 2.8.13.7.1 Navigate to the Library and select "Size Standard".
- 2.8.13.7.2 Select "Create".
- 2.8.13.7.3 Assign the name "PP16HS_ILS600".
- 2.8.13.7.4 Select "Red" for the Dye Color.
- 2.8.13.7.5 Type the following into the left column: 60, 80, 100, 120, 140, 160, 180, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, 500, 550 and 600. Click "Add Size(s)".

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

2.8.13.7.6 Click "Save".

Size Standard:

Edit Size Standard PP16HS_ILS600

Setup a Size Standard

* Size Standard: PP16HS_ILS600 ☐ Locked

Description:

* Dye Color: Red

Enter sizes in the field below separated by a comma, space, or return then click the "Add Size(s) >>" button to add them to the current size standard definition.

Enter new Size Standard definition: (e.g. 11.0, 34.2, 55)

* Current Size Standard definition: Delete Selected Sizes

60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
225.0
250.0
275.0
300.0
325.0
350.0
375.0

Add Size(s) >>

Close Save

2.8.13.8 Create a QC Protocol

- 2.8.13.8.1 Navigate to the Library and select "QC Protocols".
- 2.8.13.8.2 Select "Create".
- 2.8.13.8.3 Assign the name "PP16HS_ILS600".
- 2.8.13.8.4 Change settings to match the figure below.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

QC Protocol:

Edit QC Protocol PP16HS_ILS600

Setup a QC Protocol

* Protocol Name: PP16HS_ILS600 ☐ Locked

Description:

Size Standard: PP16HS_ILS600

Sizecaller: SizeCaller v1.1.0

Analysis Settings **QC Settings**

Analysis Range: Full Sizing Range: Partial Size Calling Method: Local Southern

Analysis Start Point: 0 Sizing Start Size: 60

Analysis Stop Point: 1000000 Sizing Stop Size: 600

	Blue	Green	Yellow	Red	Purple	Orange
Peak Amplitude Threshold	<input checked="" type="checkbox"/> 50	<input checked="" type="checkbox"/> 50	<input checked="" type="checkbox"/> 50	<input checked="" type="checkbox"/> 50	<input type="checkbox"/> 175	<input type="checkbox"/> 175

Common Settings

Use Smoothing: Light

Use Baseline (Baseline Window (Pts)) ☒ 51

Minimum Peak Half Width: 2

Peak Window Size: 15

Polynomial Degree: 3

Slope Threshold Peak Start: 0.0

Slope Threshold Peak End: 0.0

Close Save

2.8.13.8.5 Click "Save".

2.8.13.9 Create an Assay

2.8.13.9.1 Navigate to the Library and Select "Assays".

2.8.13.9.2 Select "Create".

2.8.13.9.3 Assign a descriptive assay name (ex. PP16HS_3kV3s).

2.8.13.9.4 Select "HID" for the Application Type.

2.8.13.9.5 Select "PP16HS_ILS600" as the QC Protocol.

2.8.13.9.6 Select the appropriate instrument protocol created in 2.8.24.6.

Assay:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Edit Assay PP16HS_3kV3s

Setup an Assay

* Assay Name: PP16HS_3kV3s ☐ Locked Color: Green

Application Type: HID

Protocols

Do you wish to assign multiple instrument protocols to this assay? ☒ No ☐ Yes

* Instrument Protocol: PP16HS_3kV3s Edit Create New

* QC Protocol: PP16HS_ILS600 Edit Create New

GeneMapper IDX Protocol: Edit Create New

Close Save

- 2.8.13.9.7 Click "Save".
- 2.8.13.9.8 An assay shall be created for each instrument protocol.
- 2.8.13.9.9 If multiple instrument protocols need to be run on the same samples an assay shall be created for that combination of protocols.
- 2.8.13.9.10 Follow steps 2.8.24.9.1 to 2.8.24.9.6.
- 2.8.13.9.11 Select "Yes" to assign multiple instrument protocols to this assay.
- 2.8.13.9.12 Select each desired instrument protocol and click "Add to List".
- 2.8.13.9.13 Click "Save".

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Assay – Multiple Injections:

Edit Assay PP16HS_3kV3s_3kV8s

Setup an Assay

* Assay Name: PP16HS_3kV3s_3kV8s ☐ Locked Color: Cyan

Application Type: HID

Protocols

Do you wish to assign multiple instrument protocols to this assay? ☐ No ☒ Yes

Instrument Protocols

Available Library: Add To List Create New

2 Instrument Protocol(s) Assigned to this Assay

Edit Remove Move Up Move Down

Injection	Instrument Protocol
1	PP16HS_3kV3s
2	PP16HS_3kV8s

NOTE: Order the list of protocols in the order you want them injected

* QC Protocol: PP16HS_ILS600 Edit Create New

GeneMapper IDX Protocol: Edit Create New

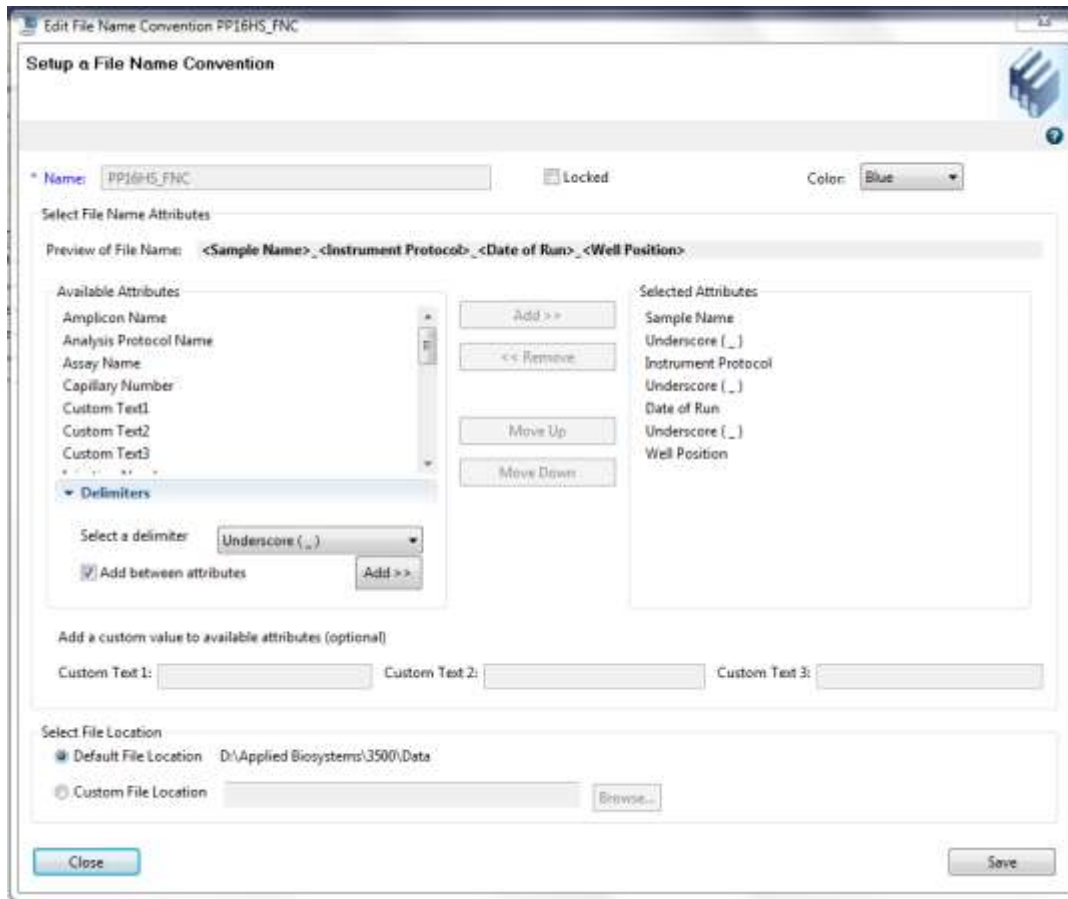
Close Save

2.8.13.10 Create a Naming Convention

- 2.8.13.10.1 Navigate to the Library and Select "File Name Convention".
- 2.8.13.10.2 Select "Create".
- 2.8.13.10.3 Assign a descriptive name (ex. PP16HS_FNC).
- 2.8.13.10.4 Select desired attributes and click "Add".
- 2.8.13.10.5 Select desired delimiters and click "Add".
- 2.8.13.10.6 Click so the "Add between attributes" box is checked.
- 2.8.13.10.7 The order of the attributes and delimiters can be changed using the "Move Up" and "Move Down" buttons.
- 2.8.13.10.8 Leave file location as the default.
- 2.8.13.10.9 Look at the "Preview of File Name" field for accuracy and Click "Save".

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

File Name Convention:



2.8.13.11 Create a Results Group

- 2.8.13.11.1 Navigate to the Library and Select “Results Group”.
- 2.8.13.11.2 Select “Create”.
- 2.8.13.11.3 Assign a descriptive assay name (ex. PP16HS_RG).
- 2.8.13.11.4 Select the desired attributes and click “Add”.
- 2.8.13.11.5 Select the desired delimiters, click the “Add between attributes” box and click “Add”.
 - 2.8.13.11.5.1 The order of the attributes and delimiters can be changed using the “Move Up” and “Move Down” buttons.
- 2.8.13.11.6 Ensure that “Store reinjection sample file with original sample files (same level)” is selected.
- 2.8.13.11.7 Leave file location as the default.
- 2.8.13.11.8 Click so the “Include a Result Group Name folder” box is selected.
- 2.8.13.11.9 Look at the “Preview of “Results Group Name” field for accuracy and Click “Save”.

Results Group:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Edit Results Group PP16HS_RG

Setup a Results Group

Name: PP16HS_RG Locked Color: Dark Blue

Select Results Group Attributes

Preview of Results Group Name: <Plate Name>-<IP Name>

Available Attributes

Assay Name

Injection Number

Delimiters

Select a delimiter Dash (-) Add >>

Add between attributes

Selected Attributes

Plate Name

IP Name

Add >> << Remove Move Up Move Down

Enter a custom value as either the Prefix or Suffix (optional)

Prefix Suffix

Select Reinjection Folder Option

☐ Store reinjection sample files in a separate Reinjection folder (same level as Injection folders)

☒ Store reinjection sample files with original sample files (same level)

Select Folder Option

☒ Default file location D:\Applied Biosystems\3500\Data\<Plate Name>-<IP Name>

☐ Custom file location Browse...

☐ Include an Instrument Run Name folder

☒ Include a Result Group Name folder

☐ Include an Injection folder

Close Save

2.8.14 Applied Biosystems 3500 Genetic Analyzer - Data Collection Software version 2.0 - PowerPlex® 16 HS Electrophoresis

2.8.14.1 Sample Preparation

- 2.8.14.1.1 **Note:** The quality of formamide is critical for the successful detection of a DNA profile. Deionized formamide shall be used that has a conductivity of less than 100µS/cm, such as Hi-Di™ Formamide. The formamide shall be frozen in aliquots at -20°C and the remainder of each aliquot shall be discarded after it is thawed. Multiple freeze-thaw cycles or long-term storage at 4°C may cause breakdown of the formamide which can create ions that compete with DNA during injection. This will cause lower peak heights and decreased sensitivity.
- 2.8.14.1.2 **Caution:** Formamide is an irritant and teratogen; therefore universal precautions and a fume hood shall be utilized when manually working with formamide to avoid inhalation and contact with the skin.
- 2.8.14.1.3 Thaw the ILS 600, the allelic ladder, and an aliquot of Hi-Di™ Formamide. When thawed, centrifuge briefly then vortex to mix (do not centrifuge the ILS after vortexing).

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

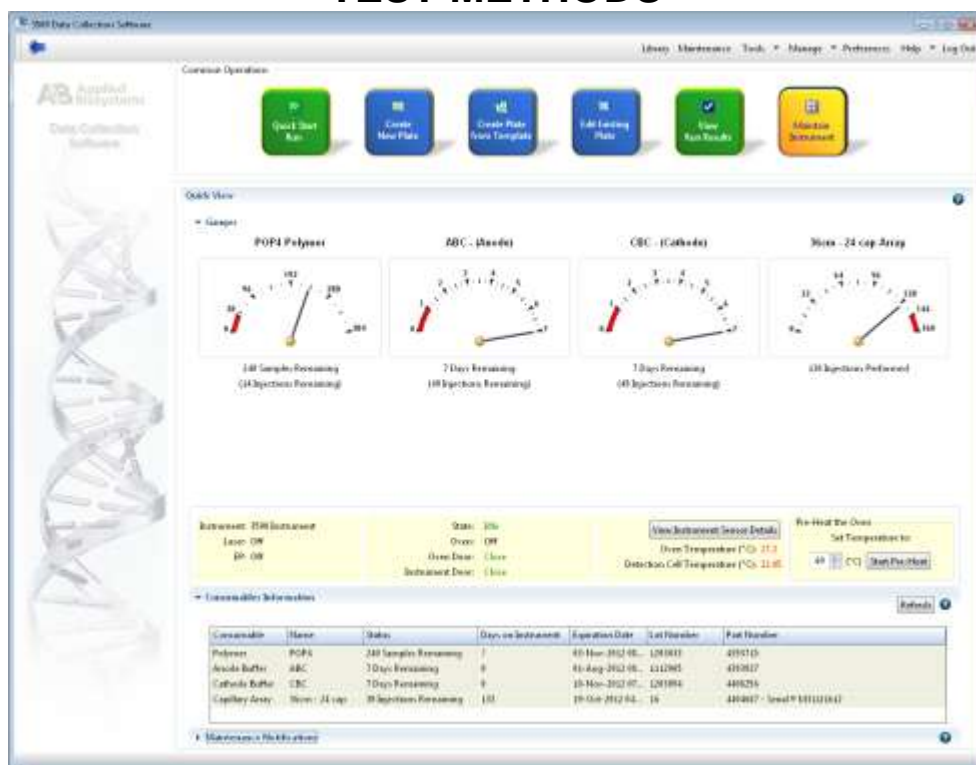
- 2.8.14.1.4 Determine the number of samples to be injected, including controls (reagent blanks, positive control and amplification blank) and allelic ladders. Add 2 to 4 reactions to this number to compensate for the loss that occurs during reagent transfers.
- 2.8.14.1.5 Prepare a loading cocktail by combining the internal lane standard (ILS 600) with the Hi-Di™ Formamide as follows:
- 2.8.14.1.6 $[(1 \mu\text{l ILS 600}) \times (\# \text{ samples})] + [(9 \mu\text{l Hi-Di}^{\text{TM}} \text{ Formamide}) \times (\# \text{ samples})]$
(recommended)
- 2.8.14.1.7 The volume of ILS 600 used in the loading cocktail may be decreased to optimize size standard peaks. The optimal range of peak heights for the size standard will vary based on the injection protocol. Targeting peak heights between ~500 RFU and ~4000 RFU should be sufficient to minimize pull-up peaks into the other dyes channels. Optimization of size standard peaks to limit the observation of pull-up while maintaining sufficient peak heights can be obtained by using 0.5 to 1.0 μl of ILS 600 per well. The amount of Hi-Di™ Formamide shall be adjusted so that the total amount of loading cocktail for each well is 10 μl .
- 2.8.14.1.8 Vortex to mix.
- 2.8.14.1.9 Pipette 10 μl of the formamide/ILS 600 mixture into each well. (Add formamide or formamide/ILS mixture into empty wells to complete an injection set of eight or twenty-four. Every well in which an injection is occurring must contain liquid.) Alternatively, the robot workstation may be utilized.
- 2.8.14.1.10 Add 1 μl of amplified sample or 1 μl of the allelic ladder to each well. It is recommended that one allelic ladder is injected within each set of 3 injections on the 8 capillary 3500 (one ladder per 24 capillaries) instruments and within each injection on the 24 capillary 3500xL (one ladder per 24 capillaries) instrument to ensure that a usable ladder injection occurs. At least one allelic ladder is required within each run folder.
- 2.8.14.1.11 Cover the wells with the plate septa and briefly spin down to remove air bubbles.
- 2.8.14.1.12 Denature the samples at 95°C for ~3 minutes, then immediately chill on crushed ice or a cold pack for ~3 minutes. Denature the samples just prior to loading the instrument. Avoid denaturing the samples for longer than 3 minutes as extended heat denaturing can lead to the appearance of artifacts.

2.8.14.2 Creating a Plate Record

- 2.8.14.2.1 Open the 3500 Data Collection Software. The Dashboard screen will launch. Ensure that the Consumable Information and Maintenance Notifications are acceptable. The oven temperature should be set to 60°C.
- 2.8.14.2.2 Select "Start Pre-Heat". This should be done at least 30 minutes prior to the first injection.

Dashboard:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



2.8.14.2.3 Select “Create New Plate”. Alternatively, “Create Plate from Template” may be used.

2.8.14.2.3.1 Assign the plate name with the laboratory case number, the date and the injection number of the plate (ex. 00A1234_01Jan13_01).

2.8.14.2.3.1.1 If the plate is re-injected the “01” number shall increase sequentially (00A1234_01Jan13_02).

2.8.14.2.3.1.2 If the plate is re-injected on a different day, the original date should still be used from when the plate was prepared.

2.8.14.2.3.1.3 If a second preparation of a plate is made on the same date as the first, it shall be designated with a “-2” after the date (00A1234_01Jan13-2_01).

2.8.14.2.4 Select “96” for Number of Wells.

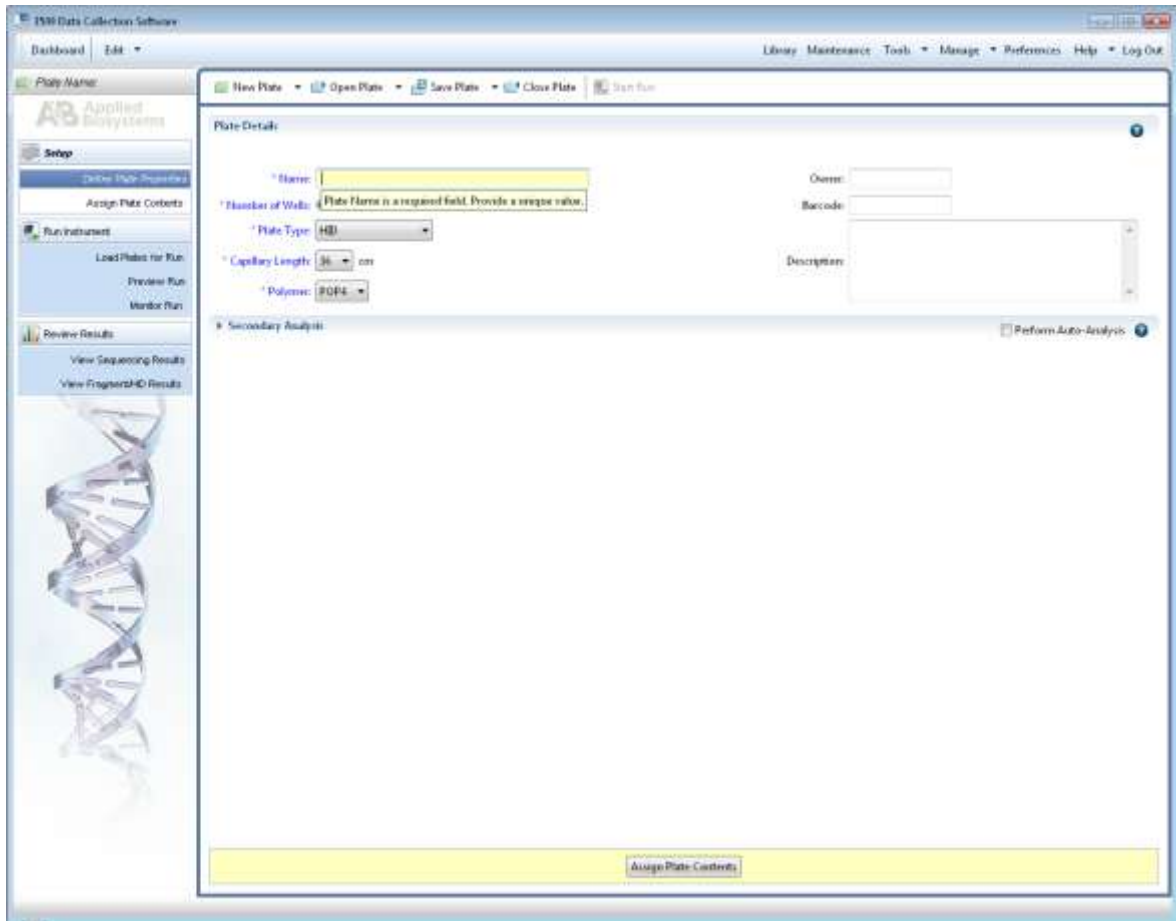
2.8.14.2.5 Select “HID” for Plate Type.

2.8.14.2.6 Select “36” for Capillary Length.

2.8.14.2.7 Select “POP4” for Polymer.

Create A Plate:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



2.8.14.2.8 Click on “Assign Plate Contents”.

2.8.14.2.9 Enter sample information or import a plate record.

2.8.14.2.9.1 The sample name shall include the sample sub-item as well as the laboratory case number (ex. 1A1_00A1234) if more than one case is included on the plate. If only one case is present on the plate then only the subitem number is required.

2.8.14.2.9.2 In order to aid in GeneMapper® ID-X sample analysis, it is recommended to place a “z” in front of the sample name for known standards (ex. z1A1_00A1234”) here or in Genemapper ID-X under sample name.

2.8.14.2.10 Under “Assays” click “Add from Library” and select the appropriate assay. Click “Add to Plate” then “Close”.

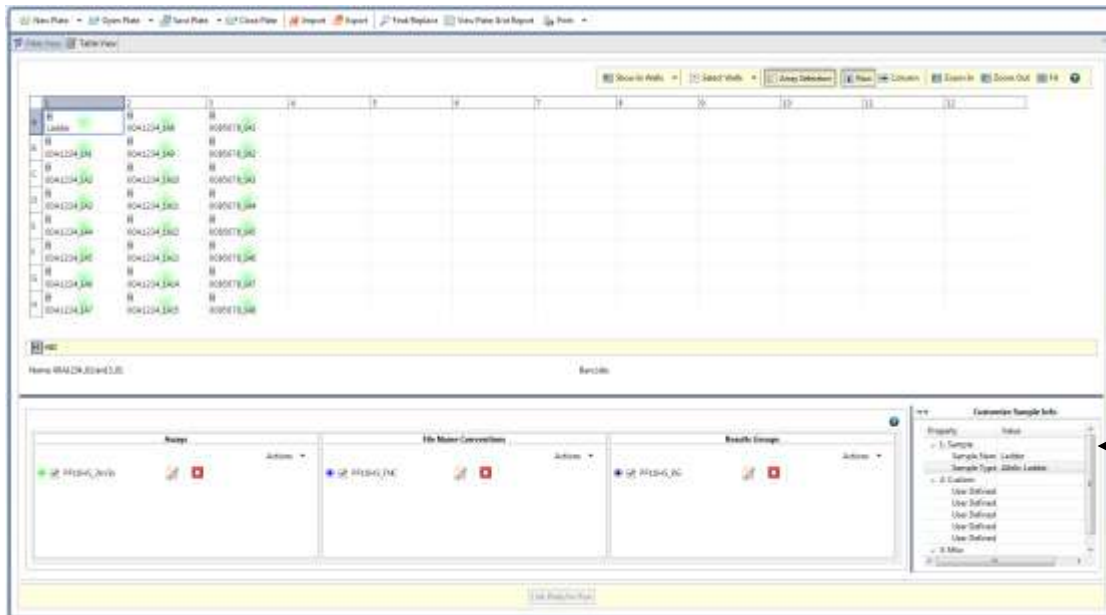
2.8.14.2.11 To add an additional assay to the plate, click the “Actions” arrow, select “Add from Library” and select the appropriate assay.

2.8.14.2.12 Under “File Name Convention”, click “Add from Library” and select “PP16HS_FNC”. Click “Add to Plate” then “Close”.

2.8.14.2.13 Under “Results Groups”, click “Add from Library” and select “PP16HS_RG”. Click “Add to Plate” then “Close”.

Assign Plate Contents:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



2.8.14.2.14 On the bottom-right side of the screen expand the “Customize Sample Info” window so it appears as shown above.

2.8.14.2.14.1 Use the drop-down box to select a sample type for each sample (ex. Ladder, Sample, Positive Control and Negative Control). For imported plates, this will be done automatically.

2.8.14.2.14.2 Minimize the “Customize Sample Info” window.

2.8.14.2.15 Highlight the sample wells and then select the boxes in the Assays, File Name Conventions and Results Groups that pertain to those samples.

2.8.14.2.16 Place plate on instrument in position A. Select “Link Plate for Run”. Click “OK”. The instrument automatically senses the plate and puts the information in the Plate A field. Click “OK”.

2.8.14.2.17 To add a second plate, follow steps 2.8.25.2.3 through 2.8.25.2.15. Place the plate in position B. Select the “Link Plate for Run” and click “OK”. The instrument automatically senses the plate and put the information in the Plate B field. Click “OK”.

2.8.14.3 Start a Plate Run

2.8.14.3.1 A unique run name is automatically generated by the instrument for each plate.

2.8.14.3.2 If you want to perform the injections in a certain order, click “Create Injection List” and use the arrows to re-order the injections.

2.8.14.3.3 Click “Start Run”.

2.8.14.3.4 After the run is complete, click “Unlink Plate” and remove it from the instrument.

2.8.14.3.5 Fill out a Plate Record Worksheet for each plate. Copies of the plate record worksheet shall be maintained in the case record.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

2.8.15 Setting Up GeneMapper® ID-X Version 1.4 Software User Accounts and the Security System

2.8.15.1 Setting Up Password Policies

- 2.8.15.1.1 Open the GeneMapper® ID-X version 1.4 software.
- 2.8.15.1.2 Login using an administrator user account.
- 2.8.15.1.3 Select “Admin” then “Security Manager.”
- 2.8.15.1.4 Login with the same administrator user account.
- 2.8.15.1.5 Select “Settings” then “Password Policies.”
- 2.8.15.1.6 Change the settings to match Figure 1.

Figure 1: Password Policies

The screenshot shows the 'Password Policies' dialog box with the following settings:

- Attempts:**
 - Max Login Attempts: 5 count
 - Upon Failure:**
 - ☒ Send log message
 - Set User State:**
 - ☐ Remain active
 - ☒ Suspend for 10 min(s)
- Password:**
 - ☐ Password Lifetime: 90 days
 - Password Grace Logins: 6 count
- Password Reusability:**
 - ☒ Password Reuse Period: 30 days
 - Passwords kept per user: 10 count
- Password Format:**
 - Minimum Password Length: 6 characters

Buttons at the bottom: Save Changes, Cancel.

- 2.8.15.1.7 Save changes.

2.8.15.2 Creating a User Group

- 2.8.15.2.1 Open the Security Manager.
- 2.8.15.2.2 Select the appropriate default user group in the left navigation pane (e.g. “Casework User Group”).
- 2.8.15.2.3 Select “Edit” then “Duplicate.”
- 2.8.15.2.4 In the “General” section, enter a name for the user group (e.g. “ISP Casework User Group”).

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.8.15.2.5 In the “Default Rights” section, make sure the “Read” and “Update” options are checked.
- 2.8.15.2.6 Select the “Security Groups” tab. Ensure all associated security groups are checked, including the “GeneMapper ID-X” security group.

2.8.15.3 Creating a Security Group

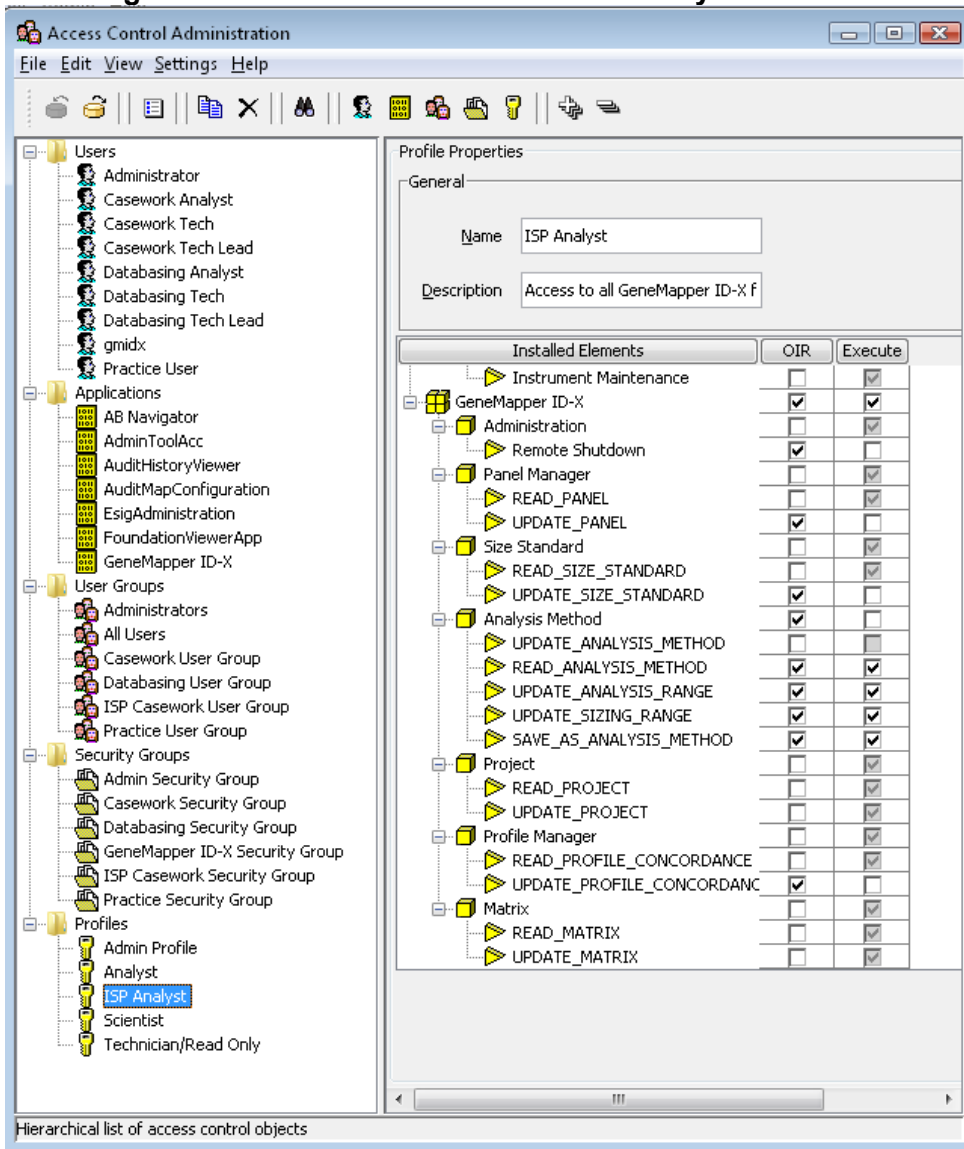
- 2.8.15.3.1 Open the Security Manager.
- 2.8.15.3.2 Select the appropriate default security group in the left navigation pane (e.g. “Casework Security Group”).
- 2.8.15.3.3 Select “Edit” then “Duplicate.”
- 2.8.15.3.4 In the “General” section, enter a name for the security group (e.g. “ISP Casework Security Group”).
- 2.8.15.3.5 In the “Associate” column, select the appropriate user groups to associate with that security group (e.g. “ISP Casework User Group”). Make sure the Read and Update options are checked for the selected user groups.

2.8.15.4 Creating a Profile

- 2.8.15.4.1 Open the Security Manager.
- 2.8.15.4.2 Select the appropriate default profile in the left navigation pane (e.g. “Analyst”).
- 2.8.15.4.3 Select “Edit” then “Duplicate.”
- 2.8.15.4.4 In the “General” section, enter a name for the profile (e.g. “ISP Analyst”).
- 2.8.15.4.5 In the “Installed Elements” table, select allowed actions for that particular profile. Allowed actions are not automatically inherited from the default profile and have to be manually entered. For the “ISP Analyst” profile, check the same allowed actions as those for the default GeneMapper® ID-X “Analyst” profile, with the exception of the “Update Panel” and “Update Size Standard” actions. Change those actions to match the selections in Figure 2.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Figure 2: Allowed Actions of the “ISP Analyst” Profile



2.8.15.5 Setting Up A User Account

- 2.8.15.5.1 Open the “Security Manager.”
- 2.8.15.5.2 Select the appropriate default user type in the left navigation pane for that particular user (e.g. “Casework Analyst”).
- 2.8.15.5.3 Select “Edit” then “Duplicate.”
- 2.8.15.5.4 In the “General” section, enter a name. This will be the login name.
- 2.8.15.5.5 In the “User Details” section, enter a full name. Leave the status set to “Active.” Uncheck “Show EULA.”
- 2.8.15.5.6 Select a profile (e.g. “ISP Analyst”).
- 2.8.15.5.7 Select one or more user groups (e.g. “ISP Casework User Group”).

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.8.15.5.8 In the “Password” section, select “Set Password.” Enter the same password twice and click “OK.” Check “Pre-Expire.”

2.8.16 GeneMapper® ID-X Version 1.4 Software - PowerPlex® 16 HS Software Settings

2.8.16.1 Importing Panel and Bin Files

- 2.8.16.1.1 Open the GeneMapper® ID-X version 1.4 software.
- 2.8.16.1.2 Select “Tools” then “Panel Manager”.
- 2.8.16.1.3 Highlight the “Panel Manager” icon in the navigation pane.
- 2.8.16.1.4 Select “File” then “Import Panels”.
- 2.8.16.1.5 Navigate to the saved panel, bin, and stutter files. Select “PowerPlex16HS_ISPv3_IDX1.4.0_Panels.txt” then click “Import”.
- 2.8.16.1.6 Select the “ISP Casework Security Group.” Click “OK.”
- 2.8.16.1.7 In the navigation pane, highlight the “PowerPlex16HS_ISPv3_IDX1.4.0_Panels” folder.
- 2.8.16.1.8 Select “File” then “Import Bin Set”.
- 2.8.16.1.9 Select “PowerPlex16HS_ISPv3_IDX1.4.0_Bins.txt” then click “Import”.
- 2.8.16.1.10 In the navigation pane, highlight the “PowerPlex16HS_ISPv3_IDX1.4.0_Panels” folder.
- 2.8.16.1.11 Select “File” then “Import Marker Stutter.” A warning box will appear asking to overwrite the current values. Select “Yes”.
- 2.8.16.1.12 Select “PowerPlex16HS_ISPv3_IDX1.4.0_Stutter.txt” then click “Import.” This will import the Promega Marker Stutter file that has been modified to include the Indiana State Police PowerPlex® 16 HS stutter percentages for filtering out stutter as determined by internal validation studies.
- 2.8.16.1.13 In the Panel Manager window, select “Apply”, then “OK”.

2.8.16.2 Creating a Casework Analysis Method

- 2.8.16.2.1 Select “Tools”, then “GeneMapper® ID-X Manager”.
- 2.8.16.2.2 Select the Analysis Methods tab.
- 2.8.16.2.3 Select “New” and a new analysis method dialog box will open.
- 2.8.16.2.4 Enter the name “3500_PP16 HS”.
- 2.8.16.2.5 Select the “ISP Casework Security Group”.
- 2.8.16.2.6 Enter 3500 as the instrument.
- 2.8.16.2.7 Select the “Allele” tab. In the “Bin Set” drop-down menu select “PowerPlex16_ISPv3_IDX1.4.0_Bins”. Ensure that the “Use marker-specific stutter ratio if available” box is checked. Enter the values shown in the following figure for proper filtering of stutter peaks.

Allele Tab:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

The screenshot shows the 'Analysis Method Editor' window with the 'Peak Detector' tab selected. The 'Bin Set' is set to 'PowerPlex16HS_ISPv3_IDX1.4.0_Bins'. A checkbox 'Use marker-specific stutter ratio and distance if available' is checked. Below this is a table for 'Marker Repeat Type' settings for Tri, Tetra, Penta, and Hexa markers. The 'Amelogenin Cutoff' is set to 0.0. At the bottom are buttons for 'Range Filter...', 'Factory Defaults', 'Save As', 'Save', 'Cancel', and 'Help'.

Marker Repeat Type:		Tri	Tetra	Penta	Hexa
Global Cut-off Value		0.0	0.0	0.0	0.0
MinusA Ratio		0.0	0.1	0.0	0.0
MinusA Distance	From	0.0	1.5	0.0	0.0
	To	0.0	2.5	0.0	0.0
Global Minus Stutter Ratio		0.0	0.0	0.0	0.0
Global Minus Stutter Distance	From	2.25	3.25	3.75	0.0
	To	3.75	4.75	5.75	0.0
Global Plus Stutter Ratio		0.079	0.0	0.0	0.0
Global Plus Stutter Distance	From	2.25	0.0	0.0	0.0
	To	3.75	0.0	0.0	0.0

Amelogenin Cutoff: 0.0

2.8.16.2.8 Select the “Peak Detector” tab. Change the settings to match those shown in the following figure.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Peak Detector Tab:

The screenshot shows the 'Analysis Method Editor' window with the 'Peak Detector' tab selected. The 'Peak Detection Algorithm' is set to 'Advanced'. Under 'Ranges', 'Analysis' is 'Full Range' and 'Sizing' is 'Partial Sizes'. 'Start Pt' is 2000 and 'Stop Pt' is 10000. 'Start Size' is 60 and 'Stop Size' is 600. Under 'Smoothing and Baseline', 'Smoothing' is set to 'Light' and 'Baseline Window' is 51 pts. Under 'Size Calling Method', 'Local Southern Method' is selected. Under 'Peak Detection', 'Peak Amplitude Thresholds' are B: 50, R: 50, G: 50, P: 50, Y: 50, O: 50. 'Min. Peak Half Width' is 2 pts, 'Polynomial Degree' is 3, and 'Peak Window Size' is 15 pts. 'Slope Threshold' is 0.0 for both 'Peak Start' and 'Peak End'. The 'Normalization' checkbox is unchecked. A 'Factory Defaults' button is at the bottom right of the settings area. At the very bottom of the window are 'Save As', 'Save', 'Cancel', and 'Help' buttons.

- 2.8.16.2.9 The Peak Amplitude Threshold (analytical threshold) values were determined to be 50 RFU for PowerPlex® 16 HS 30 cycle amplification. The analytical threshold value shall be calculated during validation for each 3500 instrument in the Indiana State Police laboratory system and may vary. If different threshold values are used, they must be posted on the instrument with the documented approval of the Technical Leader entered into the maintenance log.
- 2.8.16.2.10 Select the “Peak Quality” tab. Change the settings to match the following figure.

Peak Quality Tab:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

The screenshot shows the 'Analysis Method Editor' window with the 'SQ & GQ Settings' tab selected. The window contains several sections with input fields and dropdown menus. The 'Min/Max Peak Height (LPH/MPH)' section has three fields: 'Homozygous min peak height' (250.0), 'Heterozygous min peak height' (50.0), and 'Max Peak Height (MPH)' (28000.0). The 'Peak Height Ratio (PHR)' section has one field: 'Min peak height ratio' (0.65). The 'Broad Peak (BD)' section has one field: 'Max peak width (basepairs)' (1.5). The 'Allele Number (AN)' section has two fields: 'Max expected alleles: For autosomal markers & AMEL' (6) and 'For Y markers' (1). The 'Allelic Ladder Spike' section has two fields: 'Spike Detection' (Disable) and 'Cut-off Value' (0.2). The 'Sample Spike Detection' section has one field: 'Spike Detection' (Disable). A 'Factory Defaults' button is located at the bottom right of the settings area. At the very bottom of the window are four buttons: 'Save As', 'Save', 'Cancel', and 'Help'.

Section	Setting	Value
Min/Max Peak Height (LPH/MPH)	Homozygous min peak height	250.0
	Heterozygous min peak height	50.0
	Max Peak Height (MPH)	28000.0
Peak Height Ratio (PHR)	Min peak height ratio	0.65
Broad Peak (BD)	Max peak width (basepairs)	1.5
Allele Number (AN)	Max expected alleles: For autosomal markers & AMEL	6
	For Y markers	1
Allelic Ladder Spike	Spike Detection	Disable
	Cut-off Value	0.2
Sample Spike Detection	Spike Detection	Disable

2.8.16.2.11 Select the "SQ and GQ Settings" tab. Change the settings to match the following figure.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Peak Quality Tab:

Analysis Method Editor

General | Allele | Peak Detector | Peak Quality | SQ & GQ Settings

Quality weights are between 0 and 1.

Sample and Control GQ Weighting

Broad Peak (BD)	<input type="text" value="0.8"/>	Allele Number (AN)	<input type="text" value="1.0"/>
Out of Bin Allele (BIN)	<input type="text" value="0.8"/>	Low Peak Height (LPH)	<input type="text" value="0.3"/>
Overlap (OVL)	<input type="text" value="0.8"/>	Max Peak Height (MPH)	<input type="text" value="0.3"/>
Marker Spike (SPK)	<input type="text" value="0.3"/>	Off-scale (OS)	<input type="text" value="0.8"/>
AMEL Cross Check (ACC)	<input type="text" value="0.0"/>	Peak Height Ratio (PHR)	<input type="text" value="0.3"/>

Control Concordance (CC) Weight = 1.0 (Only applicable to controls)

SQ Weighting

Broad Peak (BD)

Allelic Ladder GQ Weighting

Spike (SSPK/SPK) Off-scale (OS)

SQ & GQ Ranges

Pass Range: Low Quality Range:

Sizing Quality: From to 1.0 From 0.0 to

Genotype Quality: From to 1.0 From 0.0 to

Reset Defaults

Save As Save Cancel Help

2.8.16.2.12 Select "Save."

2.8.16.3 Creating a Size Standard

2.8.16.3.1 Select "Tools", then "GeneMapper Manager".

2.8.16.3.2 Select the "Size Standard" tab and click "New".

2.8.16.3.3 Name the size standard "ILS HS" in the "Size Standard Editor" screen, choose the "ISP Casework Security Group", and choose red as the color for the size standard dye.

2.8.16.3.4 Enter the sizes of the 21 allelic ladder fragments: 60, 80, 100, 120, 140, 160, 180, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, 500, and 550bp.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

2.8.16.3.5 Select "OK".

2.8.16.4 Creating a Table Setting

2.8.16.4.1 Select "Tools", then "GeneMapper Manager".

2.8.16.4.2 Select the "Table Setting" tab and click "New".

2.8.16.4.3 Under the "General" tab name the Table Setting "PP16 HS" and select the "ISP Casework Security Group".

2.8.16.4.4 Under the "Samples" tab ensure that check marks are located next to only the following: Status, Sample File, Sample Name, Sample Type, Analysis Method, Panel, Size Standard, Sizing Quality Overridden, Sample File Not Found, Sample Off-scale, and Sizing Quality. Leave the font "Arial" and the size 11. Sort by "Sample Type" and then by "Sample Name." Select the "Ascending" option for both, and leave the final sort option to "None."

2.8.16.4.5 Under the "Genotypes" tab ensure that check marks are located next to only the following: Sample Name, Marker, Allele, and Height. Sort by "Sample Name," then by "Marker," and then by "None." Select the "Ascending" option for all three. Change the "Show number of alleles" to 8 and check "Keep Allele, Size, Height, Area, Data Point, Mutation and Comment together". (If the option to "Keep Allele, Size, Height..." is not visible in the window, expand the window size until the option appears.) Leave the font "Arial" and the size 11.

2.8.16.4.6 Select "OK."

2.8.16.5 Creating a Plot Setting – Samples, Controls, and Ladders

2.8.16.5.1 Select "Tools", then "GeneMapper Manager".

2.8.16.5.2 Select the "Plot Settings" tab and click "New".

2.8.16.5.3 Under the "General" tab name the Plot Setting "PP16 HS" and select the "ISP Casework Security Group".

2.8.16.5.4 Under the "Sample Header" tab ensure that check marks are located next to the following: Sample File, Sample Name, Panel, Sizing Quality Overridden, Sample Off-Scale, and Sizing Quality.

2.8.16.5.5 Under the "Genotype Header" tab ensure that check marks are located next to the following: Sample File, Sample Name, Panel, Marker, Off-scale, Out of Bin Allele, Peak Height Ratio, Control Concordance, and Genotype Quality.

2.8.16.5.6 Under the "Sizing Table" tab ensure that check marks are located next to the following: Dye/Sample Peak, Sample File Name, Marker, Allele, Size, Height, Area, and Data Point. Leave the font "Arial" and the size 11.

2.8.16.5.7 Select the "Labels" tab. Change the settings to match the following figure. Alternatively, if the "allele edit comment" function is not being used, "Label 4" for "Assigned Allele", "Custom Allele" and "Artifact" can be changed to "NONE".

Labels Tab:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Plot Settings Editor

General | Sample Header | Genotype Header | Sizing Table | **Labels** | Display Settings

Show Labels on Samples and Genotypes Plot:

	Assigned Allele	Custom Allele	Allelic Ladder	Artifact
Label 1:	Allele Call	Allele Call	Allele Call	Artifact Label
Label 2:	Height	Height	NONE	Height
Label 3:	Size	Size	NONE	Size
Label 4:	AE Reason for Cha...	AE Reason for Cha...	NONE	AE Reason for Cha...

Font

Font: Times New Roman

Size: 9

When opening the Plot Window:

☐ Show PQV trigger peak (LPH,MPH,BD,OS)

☐ Show data type prefixes

☒ Display virtual allele label in black

☐ Show type of edit

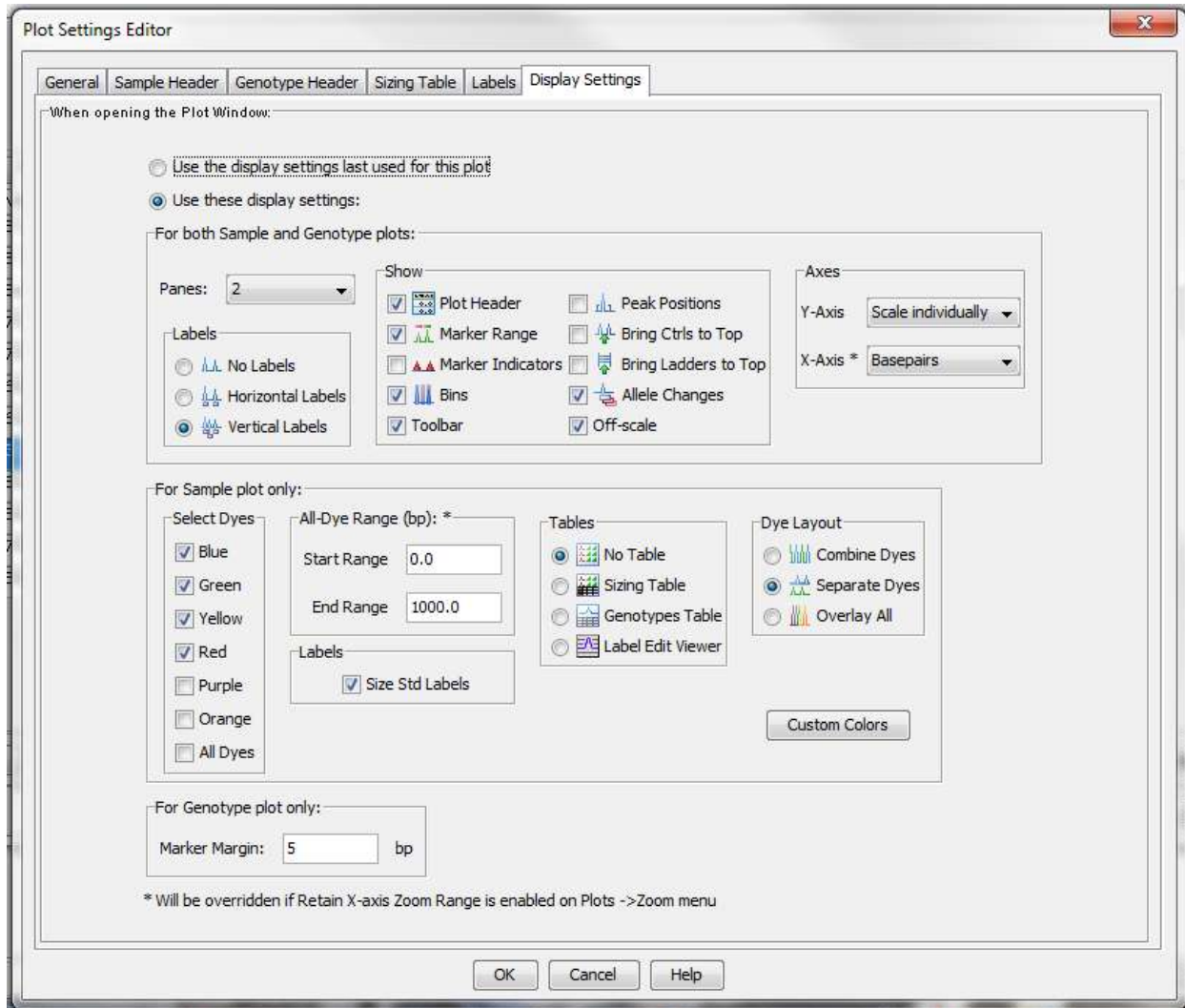
Label Color: Dye Color-Border

OK Cancel Help

2.8.16.5.8 Under the “Display Settings” tab, change the display settings so that they match the following figure.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Display Settings Tab:



2.8.16.5.9 Select "OK."

2.8.17 GeneMapper® ID-X Version 1.4 Software - PowerPlex® 16 HS Data Analysis

2.8.17.1 Processing Sample Data

- 2.8.17.1.1 Import the sample files from a single run folder by "Edit", then selecting "Add Samples to Project".
- 2.8.17.1.2 In the "Add Samples to Project" screen, navigate to the run folder that contains the sample files. If the entire run folder is to be imported, click on the folder to highlight it; then click the "Add to List" button at the bottom of the window. If only a portion of samples need to be selected, expand the folder to view the samples. Highlight the appropriate samples, ensuring that the allelic ladder and all the desired samples are selected. Once all the samples are selected click the "Add to List" button at the bottom of the window.
- 2.8.17.1.3 Only one injection parameter per project. A run folder shall not be created manually by manipulating sample files.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.8.17.1.4 Ensure that the necessary files are now located in the “Samples to Add” window by double-clicking on the folder in the right pane, then click “Add”.
- 2.8.17.1.5 After the samples have been added to the project, first briefly scan the raw data to ensure that a bad injection did not occur. To check the raw data, first expand the project folder in the left navigation pane, then click on a sample file, then click on the “Raw Data” tab in the right GeneMapper® window. To return to the “Samples” window, click on the project folder at the top of the left navigation pane.
- 2.8.17.1.6 The GeneMapper® ID-X project shall contain at least one allelic ladder from each run folder included in the project for proper genotyping. Multiple allelic ladders within a run folder will be averaged by the software to calculate the allelic bins. If a ladder injection is of low quality, delete the ladder or change the sample type from “Allelic Ladder” to “Sample” to remove it from consideration in calculating the bins.
- 2.8.17.1.7 Ensure that the table setting at the top of the screen is set to “PP16 HS”.
- 2.8.17.1.8 In the “Sample Type” column, use the drop-down menu to select “Allelic Ladder”, “Sample”, “Positive Control” or “Negative Control” for each sample.
- 2.8.17.1.9 In the “Analysis Method” column, for each sample select “3500_PP16 HS” from the drop-down menu. Click the column header cell to highlight the entire column, then select “Edit”, then “Fill Down” (or the shortcut Ctrl + D).
- 2.8.17.1.10 In the “Panel” column, for each sample select “Promega_ISPHSv3_IDX1.4.0_Panels” from the drop-down menu. Click the column header cell to highlight the entire column, then select “Edit”, then “Fill Down” (or the shortcut Ctrl + D).
- 2.8.17.1.11 In the “Size Standard” column, select “ILS HS” from the drop-down menu. Click the column header cell to highlight the entire column, then select “Edit”, then “Fill Down” (or the shortcut Ctrl + D).
- 2.8.17.1.12 The Analysis Method, Size Standard, and Panel can be set as defaults when a GeneMapper® ID-X project is opened. Under the “File” menu, select “Project Options”. Under the “Add Samples” tab select the above settings as the default in the drop-down menus for Analysis Method, Size Standard, and Panel. Click “OK.”
- 2.8.17.1.13 Select the green “Analyze” arrow button to start the data analysis. At the Project name prompt, save the project. At a minimum the project name shall contain the injection parameters for the project and date the sample run was started on the instrument. The case number is recommended but not required. Select the “ISP Casework Security Group.”

2.8.17.2 Evaluating Sample Data

- 2.8.17.2.1 The Sizing Quality shall be at least 0.49 for it to pass. All appropriate ILS peaks shall be present and labeled correctly.
- 2.8.17.2.2 Highlight all sample rows containing Allelic Ladders. Then click “View”, then “Display Plots”. In the Samples Plot screen, change the “Plot Setting” drop-down box to “PP16 HS”. Magnify the area from about 100 bp to 500 bp. Then click “File”>“Print”>“Print” to print off the allelic ladder electropherograms. Check the allelic ladders to ensure that the correct allele calls are made for

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

each peak. (Refer to the PowerPlex®16 HS System Technical Manual for current Allelic Ladder allele calls.) Close out of the Samples Plot window.

- 2.8.17.2.3 Highlight all sample rows containing negative controls (ex. amplification blanks and reagent blanks). Then click “View”, then “Display Plots”. In the Samples Plot screen, change the “Plot Setting” drop-down box to “PP16 HS”. Print off the entire electropherogram ensuring that the primer peak is visible by clicking “File”>“Print”>“Print” to print off the negative control electropherograms. Check the negative controls to ensure that no peaks above threshold are present. Close out of the Samples Plot window.
- 2.8.17.2.4 Highlight all remaining sample rows. Then click “View”, then “Display Plots”. In the Samples Plot screen, change the “Plot Setting” drop-down box to “PP16 HS”. Magnify the area from approximately 100 bp to 500 bp. After evaluating all allele calls, click “File”>“Print”>“Print” to print off all sample electropherograms. Optionally, the remaining sample rows may be viewed, evaluated, and printed with the Allelic Ladders.
- 2.8.17.2.5 After all analysis is complete, save the 3500 Data Collection Run Folder containing the sample files and associated GeneMapper® ID-X projects under each associated laboratory case number and request folder located in the analysts’ folders on the server. Projects should be deleted monthly from the “GeneMapper® ID-X Manager” to maintain database space.
- 2.8.17.2.6 When exporting the GeneMapper® ID-X project, ensure that the “Export with analysis settings” box is checked.
- 2.8.17.2.7 The number of audit records on the GeneMapper® ID-X database should be routinely checked. Audit records should be backed-up, saved to the DNA server, and then deleted from the GeneMapper® ID-X database monthly or if the number of records exceeds 40,000. If the number of audit records exceeds 60,000, the performance of the software may be affected.
- 2.8.17.2.8 The amount of database space in the GeneMapper® ID-X software should be routinely checked. If the occupied space exceeds 80%, additional disk space should be allocated.

2.8.18 General Rules For Powerplex® 16 HS Analysis On The Applied Biosystems 3500 Genetic Analyzer

- 2.8.18.1 At least one allelic ladder shall be present within a run folder. It is recommended that an allelic ladder be run within each set of 3 columns. This will help account for possible migration shifts due to external environmental factors.
- 2.8.18.2 The placement of unknown samples in the 96-well plate should be done so that the orientation allows for the injection of unknown samples prior to the injection of any standards for that case.
- 2.8.18.3 A signal range of 2,000 RFU to 15,000 RFU will produce optimal results. Optimization of signal can be obtained by changing the injection parameters. The allowable injection parameters are 3kV 3 second and 3kV 8 second injections.
 - 2.8.18.3.1 NOTE: Loading more than 1 µl will make the sample ineligible for entry into CODIS.
- 2.8.18.4 If a sample is to be re-injected at the higher injection parameters, the reagent blank and the amplification blank associated with that sample shall also be re-injected as well. The

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

positive control need not be injected at the same parameters as the samples associated with it.

- 2.8.18.5** If a selection of samples from an amplification requires re-injection at higher injection parameters with their associated blanks and the blanks at the higher parameters demonstrate some indication of contamination, the Technical Leader shall be informed. The decision to declare inconclusive all sample data or just the sample data from the higher injection parameter shall be at the discretion of the analyst with the approval of the Technical Leader documented in the case record.
- 2.8.18.6** If multiple amplifications or injection protocols are analyzed for a sample, the analyst shall use the amplification and/or injection which they determine sufficiently represents the sample based on peak heights, artifacts and noise levels. Analysts shall interpret data that most clearly represents the sample and try to achieve better resolution if a sample has peak heights that are too high (resulting in artifacts, increased instrument noise, and pull-up) or too low (resulting in allelic drop out and loss of data).
- 2.8.18.7** Only the injection(s) used for interpretation need to be printed for the case record. However, other injection runs shall be noted in the case record and all data shall be saved under each associated laboratory case number and request folder located in the analyst's folder on the server. If individual samples in a case use different injection parameters, it shall be noted in the case record which injection was used for interpretation for each sample.

2.8.19 Archiving Applied Biosystems 3500 and GeneMapper® ID Projects

- 2.8.19.1** The 3500 run folders containing all sample files for a case as well as the GeneMapper® ID-X project files shall be saved under each associated laboratory case number and request folder located in the analyst's folder on the server and deleted from the hard drive of the instrument and/or analysis computer. The data stored on the server shall be routinely backed up to ensure security of data
- 2.8.19.2** A copy of all electropherograms used in interpretation as well as a print-out of the plate record shall be placed in the case record.
- 2.8.19.3** All processed plate records shall be deleted from the Data Collection Software database weekly. Run folders containing the sample files and the GeneMapper® ID-X projects shall be deleted on or after the 15th of each month on the instrument computers. It shall be each analyst's responsibility to ensure that all data is backed up prior to the 15th of the month.

2.8.20 Interpretation Guidelines For PowerPlex® 16 HS

2.8.20.1 Scope

- 2.8.20.1.1** The following interpretation guidelines shall aid in peak/true allele determinations and profile interpretations.
- 2.8.20.1.2** It shall be at the analyst's discretion, based on experience and training, as to which peaks are suitable for interpretation.
- 2.8.20.1.3** If an analyst has determined that a peak that has been labeled by the GeneMapper® ID-X software is not a true allele peak, the analyst can rename or delete the allele call label in GeneMapper® ID-X or manually mark the change on the printed electropherogram.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 2.8.20.1.4 Final allele calls shall be documented on the appropriate worksheet (Single Source STR Summary Sheet or the Mixture Worksheet) or IndySTR printout.

2.8.20.2 Preliminary Evaluation of Allele Peaks

- 2.8.20.2.1 The analytical and stochastic threshold shall be determined during validation. The minimum peak height threshold is established at 50 relative fluorescent units (RFU) for GeneMapper® *ID-X* software analysis. The analytical and stochastic thresholds for data interpretation are shown below.

3500 (8 cap) – Ft. Wayne, Indianapolis and Lowell		
	3kV3s	3kV8s
Analytical	50 RFU	50 RFU
Stochastic	250 RFU	450 RFU
3500 (8 cap) - Evansville		
	3kV3s	3kV8s
Analytical	50 RFU	50 RFU
Stochastic	250 RFU	350 RFU
3500xL (24 cap)		
	3kV3s	3kV8s
Analytical	50 RFU	50 RFU
Stochastic	275 RFU	350 RFU

- 2.8.20.2.2 Peaks below 50 RFU shall not be interpreted or marked on the STR summary sheet, but may be considered when deciding if the possible number of contributors can be reasonably assumed.
- 2.8.20.2.3 Interpretation of peaks with RFU from the analytical threshold to the stochastic threshold (ex. 50 to 275 RFU for 3500xL 3kV3s data) is a qualitative assessment and is based on the data and case information. An allele at these RFU shall be used for interpretation purposes; however, it shall be interpreted with care. A peak in this range can be an indication of possible allelic dropout at a locus. It will be reported in brackets (ex. 9,11>[10]).
- 2.8.20.2.4 Peaks above stochastic threshold (ex. 275 RFU for 3500xL 3kV3s data) shall be used for interpretation.
- 2.8.20.2.5 Peak heights of analyzed samples should not exceed 28,000 RFU for 3500 data. Use of data with a single peak > 28,000 RFU may be used at the discretion of the analyst, more than one peak >28,000 RFU may be allowed with the approval of a Supervisor and notification to the Technical Leader documented in the case record.
- 2.8.20.2.5.1 Profiles with peaks over 28,000 RFU should be interpreted with caution, particularly regarding quantitative aspects of interpretation such as stutter, peak height ratio, and mixture ratio assessments.
- 2.8.20.2.6 An analyst is required to visually confirm that all allelic ladders used for allele designation performed correctly.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

2.8.20.2.7 Stutter peaks are artifacts of the amplification process. These peaks will typically be observed in the n-4 position of major peaks for tetranucleotide repeat loci or in the n-5 position of major peaks for the pentanucleotide repeat loci.

2.8.20.2.7.1 The peak heights of stutter peaks will be less intense than that of the major peak. The average observed percent stutter for each locus and the mean + 3 standard deviations (SD) value (99.7% confidence level) of stutter observed in validation are listed in the table below. The mean + 3 SD values are used as the stutter filter values in the marker stutter file "PowerPlex16HS_ISPv3_IDX1.4.0_Panels.txt" for GeneMapper® ID-X analysis. Therefore, any peaks in the n-4 (for tetranucleotide repeats) or n-5 (for pentanucleotide repeats) stutter positions that are below these values when compared to the major peak will be automatically filtered out by the software and will not be labeled.

LOCUS	MEAN % STUTTER	MEAN + 3SD
D3	9.37	13.98
TH01	2.43	5.17
D21	8.83	13.24
D18	7.69	14.82
Penta E	2.96	7.91
D5	6.76	10.89
D13	6.62	13.40
D7	5.47	11.61
D16	7.29	12.08
CSF	5.92	9.80
Penta D	1.58	4.06
vWA	8.47	15.83
D8	6.45	10.34
TPOX	2.96	6.26
FGA	8.56	14.27

2.8.20.2.7.2 Stutter peaks have also been documented at the n-8, n+4 or n+5 positions. These peaks will also have significantly less intense signal than the major peak. The interpretation of these peaks shall be at the discretion of the analyst based on their training and experience. The table shown below listing the observed n-8 and n+4/n+5 stutter data determined during validation may be used as a guideline in assisting with interpretation.

Locus	n-8		n+4/n+5	
	Mean	Mean+3SD	Mean	Mean+3SD
D3	0.97	1.73	1.50	2.73
TH01			0.38	0.65
D21	1.00	1.65	2.06	3.37
D18	0.82	1.69	1.24	5.82

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

PE				
D5	0.71	1.32	1.62	2.71
D13	1.08	2.36	2.40	3.61
D7	1.77	2.30	1.80	2.86
D16	1.02	2.28	1.56	3.20
CSF			1.62	3.05
PD			0.58	0.78
vWA			1.12	2.30
D8	0.61	1.26	1.17	2.39
TPOX			0.89	2.44
FGA	2.42	3.54	1.29	2.40

2.8.20.2.8 Artifacts have been observed and documented utilizing the PowerPlex® 16 HS amplification kit. The intensity of these peaks is directly related to signal intensity; therefore reducing the signal intensity below 3000 RFU should eliminate the appearance of these types of artifacts. If an analyst renames the allele call of any artifact in GeneMapper® *ID-X*, it shall be labeled appropriately. Examples of documented artifacts are listed below. Several of the listed artifacts are believed to be the result of secondary structure within the DNA molecule. This secondary structure causes differential migration; thus the artifact location listed is an approximate value.

vWA – n-10 bp, n-11 bp, n-18 bp, n-2 bp, n+2 bp, n+4 bp

D5 – n-9 bp, a floating artifact from 114 to 116 bp and 137 to 139 bp

D16 – artifacts falling within the 5 allele and 9 allele bins

D21 – n-2 bp, n+2 bp, n+4 bp

TPOX – n-9 bp, n-13 bp, n-17 bp, n-21 bp

TH01 – a floating artifact from ~n-6 bp to ~n-10 bp, n-13 bp

Penta D - n-9 bp, n-12 bp, n-17 bp

Amelogenin - 98 bp, 100 bp, 102 to 103 bp

Other low level artifacts are seen in the green and yellow channels. These may be located 8 to 26 bases smaller than TPOX alleles and 6 to 21 bases smaller than vWA alleles. These are more likely to be seen when peak heights are greater than 20,000 rfu and when the sample is homozygous at that locus.

2.8.20.2.9 Pull-up or bleed through peaks can occur if signal intensity of sample or ILS peaks are too high or if a new spectral calibration needs to be run. Any pull-up peaks called as alleles by the GeneMapper® *ID-X* software should be labeled on the electropherogram as pull-up. The sample should be re-run if a pull-up peak interferes with the analyst's ability to evaluate the profile based on their experience and training.

2.8.20.2.10 Spikes are peaks that generally appear in all colors and are sharper than regular peaks; however, they can occur predominantly in one color. Spikes

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

are a natural consequence of capillary electrophoresis and can be caused by dust present in the system as well as urea crystals in the system. It is essential that the instrumentation be maintained and cleaned regularly to minimize the appearance of spikes. All spikes called as alleles by the GeneMapper® *ID-X* software should be clearly labeled as spikes on the electropherogram printout. A sample should be re-injected when a spike interferes with the analyst's ability to evaluate the profile based on their experience and training.

2.8.20.2.11 Rare variants (microvariants) have been described in the literature. These peaks will have a similar intensity to the other major peak for that locus but will not line up with the allelic ladder or have a bin in the GeneMapper® *ID-X* PowerPlex® 16 HS panels and bins settings.

2.8.20.2.11.1 Alleles one, two or three nucleotides shorter than the common four base repeat alleles (or four nucleotides shorter in the case of five base repeat alleles) which are located between two alleles on the ladder shall be described as the short repeat followed by the number of base pairs it is larger (a 0.1, 0.2, 0.3, or 0.4 in the case of a pentanucleotide repeat). Therefore, if a peak is 1 base pair larger than the 5 allele it shall be designated as 5.1. The precision of sizing at a 99.7% confidence level is less than 0.5 bp which is precise enough to be confident in the sizing of microvariants. A microvariant 4 base pairs larger than an allele (or 5 base pairs for a pentanucleotide) on the ladder may be designated with the full repeat number (A peak 4 base pairs larger than the 5 allele could be designated a 6; 5 base pairs larger a 6.1).

2.8.20.2.11.2 Alleles which are located outside the range of the ladder or bin set (above or below) shall be described as "<" or ">" the largest or smallest allele for that locus with a set of () placed around the off ladder allele. For example, if a peak is located above the largest allele for the D16 locus, it would be designated as "(>15)". This should be clear when used and can be verified with a locus review of the electropherogram.

2.8.20.2.11.3 Any allele peak that is not present in the allelic ladder and does not have an associated "bin" in the GeneMapper® *ID-X* analysis software, shall be called "OL" by the software. The analyst can rename the allele in the software.

2.8.20.3 Evaluation of Controls

2.8.20.3.1 Failed controls require the documented notification to the Technical leader with appropriate documentation in the case record.

2.8.20.3.2 The appearance of pull-up or known artifact peaks does not render the following controls inconclusive.

2.8.20.3.3 Reagent Blank:

2.8.20.3.3.1 The purpose of the reagent blank is to determine if the reagents used to extract the associated samples were contaminated by human DNA. Therefore no signal should be detected in this sample well other than the internal lane standard. If a signal is detected in the reagent blank, all

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

results of samples associated with that reagent blank shall be considered inconclusive.

2.8.20.3.3.2 A reagent blank with peaks below 50 RFU shall not prevent associated samples from being interpreted.

2.8.20.3.3.3 A reagent blank with peaks of 50 RFU and above shall be considered a failed negative control. All associated samples shall be inconclusive. All the samples shall be repeated when appropriate.

2.8.20.3.4 **Positive Control:**

2.8.20.3.4.1 The 2800M DNA is used as a positive control to demonstrate that the kit is performing properly. If the expected alleles are not detected in the positive control well, then the test is considered inconclusive.

STR Locus	2800M
D3S1358	17,18
TH01	6,9.3
D21S11	29,31.2
D18S51	16,18
Penta E	7,14
D5S818	12,12
D13S317	9,11
D7S820	8,11
D16S539	9,13
CSF1PO	12,12
Penta D	12,13
Amelogenin	XY
vWA	16,19
D8S1179	14,15
TPOX	11,11
FGA	20,23

2.8.20.3.5 **Amplification Blank**

2.8.20.3.5.1 The purpose of the amplification blank is to determine if human DNA contaminated the samples at the amplification step. Because no template DNA was placed in the reaction tube, the sample well should be blank except for the internal lane standard peaks. If amplified product is detected in the amplification blank well, the test is considered inconclusive.

2.8.20.3.5.2 An amplification blank with peaks below 50 RFU shall not prevent associated samples from being interpreted.

2.8.20.3.5.3 An amplification blank with peaks of 50 RFU and above shall be considered a failed negative control. All associated samples shall be inconclusive. All the samples shall be repeated when appropriate.

2.8.20.4 **General Interpretation Considerations**

2.8.20.4.1 The "phenotype" of each profile shall be recorded. A homozygous locus shall be notated by a single allele. The genotype may be noted within the IndySTR program to aid in the statistical calculation for the profile.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.8.20.4.2 All interpretation decisions shall be documented prior to comparison of known profiles. (An exception is made when utilizing the profile of a known contributor to deduce a foreign profile in an intimate sample.) If an interpretation error is discovered after comparison to a known profile, the Technical Leader shall be consulted to determine the appropriate action. The error and Technical Leader consultation shall be documented in the case record.
- 2.8.20.4.3 A sample with a partial profile that has interpretable peaks at one or more loci can be reported even though no peaks are detected in the remaining loci.
- 2.8.20.4.4 During interpretation, all profiles developed from evidence (except standards) shall be compared to available staff profiles to ensure that samples have not been contaminated. Instances of profiles consistent with a staff member shall be reported to the Technical Leader and documented in the case record.
 - 2.8.20.4.4.1 Partial profiles and/or mixtures with a statistical result more common than 1 in 1,000 for all calculated populations are not required to be searched in the staff database and/or reported to the Technical Leader.
- 2.8.20.4.5 Test results from a question sample may not be suitable for comparison to a known standard and may have the following conclusions reported:
 - 2.8.20.4.5.1 No results: No peaks were detected in the electropherogram.
 - 2.8.20.4.5.2 Inconclusive: Peaks were observed at one or more loci; however no conclusive results can be drawn from them.
- 2.8.20.4.6 Test results from a question sample that are suitable for comparison to a known standard may have the following conclusions reported:
 - 2.8.20.4.6.1 Consistent/Cannot Be Excluded: The profile obtained from the question stain had no discrepant alleles as compared to the profile of the known standard. (Allelic drop-out may occur in low concentrations or mixtures.)
 - 2.8.20.4.6.2 Not consistent/Excluded: The profile obtained from the question stain had discrepant alleles as compared to the profile of the known standard, i.e. was not the same.
- 2.8.20.4.7 If conclusive results are obtained from a sample, appropriate, CODIS eligible profiles which do not match the victim shall be entered into the Indiana DNA Database for searching.
- 2.8.20.4.8 The IndySTR excel program may be used to aid in interpretation of DNA profiles, including the determination of mixture ratios and deconvolution of major/minor profiles.

2.8.20.5 Single Contributor DNA Profile Interpretation

- 2.8.20.5.1 Generally, a single source profile should contain no more than two alleles at all loci examined. However, three-peak allele patterns have been reported for single-source stains, but these instances are rare. A profile where only one locus demonstrates three alleles could be an indication of:
 - 2.8.20.5.1.1 A mixture where the minor contributor is not at levels allowing interpretation;
 - 2.8.20.5.1.2 Extraneous DNA;

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

2.8.20.5.1.3 A tri-allelic pattern. If a tri-allelic pattern is indicated, it should be confirmed by concordance to at least one additional sample contained within the case and/or re-amplification.

2.8.20.5.2 In situations 1 and 2 above, report wording to the effect that one additional allele was detected and no conclusion can be reached on the allele is appropriate. In situation 3, no mention is required in the report.

2.8.20.5.3 For single source profiles where three alleles are detected at a single locus, the ">" shall be used to indicate if the peak height ratio of the two smallest alleles is less than 0.33 on the Single Source STR Summary Sheet or in IndySTR.

2.8.20.5.4 For single source profiles, the peak height ratio (the smallest peak divided by the largest peak) of heterozygous individuals at a locus should be within 0.65.

2.8.20.5.4.1 Samples may display peak height ratios less than expected when the sample is of poor quality or the amplification target is below the ideal input of template DNA.

2.8.20.5.5 Conclusions shall be reported for all results in which the assumption of a single contributor is made.

2.8.20.6 Single Contributor Statistical Analysis (if necessary)

2.8.20.6.1 The single contributor DNA profile frequency shall be calculated using the Random Match Probability (RMP) statistic (see [Appendix 4](#)).

2.8.20.7 Multiple Contributor DNA Profile Interpretation

2.8.20.7.1 Assumptions used in the interpretation of mixtures and interpretation decisions shall be documented on the mixture interpretation worksheet and/or the IndySTR excel program.

2.8.20.7.2 Analysts shall consider the additive effects of allele sharing during interpretation.

2.8.20.7.3 The flow of mixture interpretation generally follows the steps listed below (Clayton, et al., 1998):

Identify the presence of a mixture.

Designate the allele peaks.

Identify the minimum number of contributors.

Estimate the relative ratio of the individual contributors to the mixture.

Consider all genotype combinations.

Compare reference samples.

Statistical analysis (if necessary).

2.8.20.7.4 Identify the Presence of a Mixture

2.8.20.7.4.1 A profile is defined as a mixture between two or more individuals when two or more loci demonstrate three or more alleles.

2.8.20.7.4.2 A peak height ratio less than 0.65 at a locus may indicate a mixed profile and that allele sharing may be occurring.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

2.8.20.7.4.2.1 Peaks less than the established stochastic threshold may not meet the 0.65 peak height ratio expectation for paired alleles.

2.8.20.7.4.3 Peaks in stutter position that exceed the expected stutter percentage may indicate the presence of a mixture.

2.8.20.7.4.4 All loci shall be considered when determining the presence of a mixture.

2.8.20.7.5 **Designation of allele peaks**

2.8.20.7.5.1 Alleles are designated as previously described.

2.8.20.7.5.1.1 A peak in stutter position should be considered a possible allele peak if it exceeds the established stutter percentage (mean + 3SD) or if its peak height is equal to or greater than the peak height of minor contributor alleles.

2.8.20.7.5.1.1.1 Stutter peaks shall be evaluated per locus.

2.8.20.7.5.1.1.2 Stutter shall not be considered as a possible allele at loci demonstrating peaks below the stochastic threshold.

2.8.20.7.5.1.1.3 If no independent minor contributor peaks are observed at a locus, peaks within expected stutter range shall not be considered.

2.8.20.7.5.1.1.4 The assumed number of contributors shall be used to eliminate peaks in stutter position as possible alleles.

2.8.20.7.5.1.1.5 Peaks in stutter position that have been filtered out by GeneMapper® ID-X should be considered for interpretation. The RFU value and allele call of filtered stutter peaks shall be manually recorded on the printed electropherogram if being considered for interpretation.

2.8.20.7.6 **Identify the assumed number of contributors or minimum number of contributors.**

2.8.20.7.6.1 The minimum number of contributors should be determined using the locus demonstrating the greatest number of alleles.

2.8.20.7.6.2 Peaks below analytical threshold may be taken into consideration in the determination of the number of contributors.

2.8.20.7.6.3 Allelic imbalance and the evaluation of possible genotype pairings may be taken into consideration in the determination of the number of contributors.

2.8.20.7.6.4 The evidence sample type and/or quality of the data may be taken into account in the determination of the number of contributors for a sample.

2.8.20.7.6.5 In an intimate sample, the known contributor profile may be used to determine the assumed number of contributors.

2.8.20.7.6.6 In a differential sample, the profile obtained in the corresponding sperm/non-sperm fraction may be used to determine the assumed number of contributors.

2.8.20.7.6.7 If an analyst is not reasonably confident in assuming the number of contributors, only the minimum number of contributors shall be reported.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

2.8.20.7.6.8 A profile in which a locus demonstrates more than 6 alleles or in which an analyst determines that four or more contributors may be present shall be considered too complex for interpretation. An exception may be made with Technical Leader approval and review of the final interpretation documented in the case record.

2.8.20.7.7 Assumed Two Person Mixture Interpretation

2.8.20.7.7.1 See [Appendix 2](#).

2.8.20.7.8 Assumed Three Person Mixture Interpretation

2.8.20.7.8.1 See [Appendix 3](#).

2.8.20.7.9 Mixture Interpretation When The Number of Contributors Cannot Be Reasonably Assumed

2.8.20.7.9.1 If the number of contributors cannot be reasonably assumed and it does not appear that there is a single source major profile, the mixture shall be evaluated as an indistinguishable mixture. A Combined Probability of Inclusion (CPI) statistic shall be utilized when applicable. ([See Appendix 4](#))

2.8.20.7.9.2 If the number of contributors cannot be reasonably assumed as a two or a three person mixture and there is a possible single source major profile, the guidelines for pulling a single source major profile in a three person mixture shall be followed. ([See Appendix 3](#)) A Random Match Probability (RMP) statistic shall be utilized for the major profile. No conclusion will be drawn on the minor alleles.

2.8.20.7.10 Multiple Contributor Statistical Analysis (if necessary)

2.8.20.7.10.1 See [Appendix 4](#).

2.9 Records

2.9.1 The appropriate worksheets as contained in the Worksheet Manual, IndySTR or the equivalent workbooks shall be used to record all procedures.

2.9.2 All data sheets, notes, photographs, and other information generated from the laboratory examination shall be kept in the case record.

2.9.3 The technical review of the case record shall be recorded on the technical review worksheet.

2.9.4 Electronic records shall be retained as indicated in [Appendix 7](#).

2.10 Interpretations of Results

2.10.1 Interpretations guidelines are located within the Procedures section 2.8 and Appendices 2-4.

2.11 Report Writing for DNA Analysis

2.11.1 General rules (see [1.11](#) for report formatting)

2.11.1.1 When a subitem is reported it shall be **bolded** if the original item is not present and was previously reported.

2.11.1.2 When a person or a group of people are excluded from a sample, they do not have to be mentioned at every sample from which they are excluded.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.11.1.3 A unique unknown individual may be indicated in a single source sample, a major profile in a mixed sample, a minor profile in an assumed two person mixed sample or a deduced profile.
 - 2.11.1.3.1 A unique unknown individual can be reported as being included/excluded from other samples in the case record at the analyst's discretion.
- 2.11.1.4 Specific genotypes shall not be reported.
- 2.11.1.5 When differential extractions are employed, the terminology "sperm [cell] fraction" and "non-sperm [cell] fraction" shall be used in the report.
- 2.11.1.6 When reporting a mixture, the assumed number of contributors shall be stated. If the analyst is not confident in assuming an exact number of contributors the phrase "at least" can be used to indicate the minimum number of contributors present.
- 2.11.1.7 All swabs in a subitem (excluding standards) not tested shall be referenced as not tested in the report using the appropriate wording.
- 2.11.1.8 When two or more samples are combined at any point in the analysis process, the report shall refer to the samples as "combined". The analyst's notes shall clearly describe which samples and at which stage of the process the samples were combined.
- 2.11.1.9 When a cross-case comparison is performed, the Indiana State Police Laboratory item XXX, *case* XXX-XXXXXX, and *Agency case* XXXX shall be used to identify the appropriate item.
 - 2.11.1.9.1 If the comparison is performed to a different agency's case implicating an individual, additional identifiers for the individual should be included whenever possible. (i.e. birth date or Department of Correction number).
 - 2.11.1.9.2 Individual items from another case should not be listed in the item descriptions or as separate items in the body of the report.
- 2.11.1.10 The appropriate CODIS statement shall be included for every report detailing a new questioned DNA profile. When profiles are entered into CODIS, the statement will be with the item. Otherwise, the CODIS statement may be at the end of the report.
- 2.11.1.11 Report wording for a CODIS hit is available in the Biology Databasing Test Method.
- 2.11.1.12 Report wording may be altered with the approval of a Biology Unit Supervisor.

2.11.2 Statistics rules

- 2.11.2.1 All positive associations (excepting owner on an intimate sample) shall have a statistical evaluation applied and reported. Specific wording is provided to be used with intimate samples.
- 2.11.2.2 Statistical evaluations of samples in which no individual can be attributed (based on the standards submitted) shall not be reported. (i.e. unknown profiles)
- 2.11.2.3 When reporting out frequency, it will be to the nearest whole person or 2 significant figures. (ex. 1 in 6.8 should be reported as 1 in 6 or 10 in 68)
- 2.11.2.4 When reporting out frequency, it can be reported numerically or in word form, (ex, 1,000,000 versus 1 million).
- 2.11.2.5 A reporting ceiling of 8 trillion will be utilized. When a calculated statistic is rarer than 8 trillion for all three population groups the phrase "more than 8 trillion" shall be utilized in place of the calculated statistic.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

2.11.2.6 Any statistical result reported prior to July 1, 2015 shall be recalculated if:

- 2.11.2.6.1 Additional evidence is submitted in the case;
- 2.11.2.6.2 The case is going to court; or
- 2.11.2.6.3 Upon request;
- 2.11.2.6.4 If the reported statistical results change, a new (2.11.2.6.1) or amended (2.11.2.6.2 and .3) shall be issued with notification included in the report and the statistical worksheets uploaded under the associated request number. If the reported statistical results do not change, the new statistical worksheets shall be uploaded under the original request number as v2.

2.11.2.7 See [Appendix 5](#) for specific wording examples.

2.12 References:

- 2.12.1 Federal Bureau of Investigation. Procedures for the Detection of Restriction Fragment Length Polymorphisms in Human DNA. FBI Laboratory. 1990.
- 2.12.2 Federal Bureau of Investigation. PCR-Based Typing Protocols. FBI Laboratory. 1994.
- 2.12.3 Applied Biosystems. 3500/3500xL Genetic Analyzer 3500 Series Software 2 User's Manual. P/N 4476988, rev. A. 5/2012.
- 2.12.4 Applied Biosystems. GeneAmp® PCR System 9700 User's Manual. P/N 4331608, rev. B. 2003
- 2.12.5 Promega Corporation. PowerPlex®16 HS System Technical Manual. Part No. TMD 022. Most current issue.
- 2.12.6 Promega Corporation. PowerPlex® Matrix Standards, 3100/3130 Technical Bulletin. Part No. TBD022. 1/06 or most current issue.
- 2.12.7 Promega Corporation. Maxwell® 16 Instrument Operation Manual. Part No. TM295. 2008 or most current issue
- 2.12.8 Promega Corporation. DNA IQ™ Casework Sample Kit for Maxwell® 16. Part No. TB 354. 2009 or most current issue.
- 2.12.9 Promega Corporation. Tissue and Hair Extraction Kit (for use with the DNA IQ™). Part No. TB307. 2006 or most current issue.
- 2.12.10 Promega Corporation. DNA IQ™ Reference Sample Kit for Maxwell® 16. Part No. TB347. 2009 or most current issue.
- 2.12.11 Applied Biosystems. GeneMapper® ID-X Software Version 1.0 Getting Started Guide. Part No. 4375574 Rev. A. 10/2007
- 2.12.12 Applied Biosystems. GeneMapper® ID-X Software Version 1.2 Reference Guide. Part No. 4426481 Rev. A. 10/2009
- 2.12.13 Applied Biosystems. GeneMapper® ID-X Software Version 1.0 Administrator's Guide. Part No. 4376327 Rev A. 09/2007.
- 2.12.14 Applied Biosystems. GeneMapper® ID-X Software Version 1.4 User Bulletin. Part No. 77684 Rev. A. 08/2012

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 2.12.15** Lins A.M., Micka K.A., Sprecher C.J., Taylor J.A., Bacher J.W., Rabbach D.R., Bever R.A., Creacy S.D., Schumm J.W., Development and population study of an eight-locus short tandem repeat (STR) multiplex system, *Journal of Forensic Sciences* 1998; 43(6):1168-1180.
- 2.12.16** Budowle, B., Moretti, T.R., Baumstark, A.L., Defenbaugh, D.A., Keys, K.M., Population Data on the Thirteen CODIS Core Short Tandem Repeat Loci in African Americans, U.S. Caucasians, Hispanics, Bahamians, Jamaicans, and Trinidadians, *Journal of Forensic Sciences* 1999; 44(6), 1277-1286.
- 2.12.17** Moretti, T.R., Budowle, B. and Buckleton, J. S., Erratum, *Journal of Forensic Sciences* 2015; 60(4).
- 2.12.18** Smith, J., Budowle, B. Source Identification of Body Fluid Stains Using DNA Profiling. Proceedings of the Second European Symposium, Innsbruck, Austria. 6/98
- 2.12.19** Budowle, B., Chakraborty, R., Carmody, G., Monson, K., Source Attribution of a Forensic DNA Profile. *Forensic Science Communications*. July 2000, Volume 24, Number 3.
- 2.12.20** Applied Biosystems. Quantifiler® DUO DNA Quantification Kit User's Manual. P/N 4391294, Rev. B. 2008.
- 2.12.21** Bär, W. et al. DNA recommendations: Further report of the DNA Commission of the ISFH regarding the use of short tandem repeat systems. *Int. J. Legal Med.* (1997) 110, 175-176.
- 2.12.22** Gill, P. et al. Considerations from the European DNA profiling group (EDNAP) concerning STR nomenclature. *Forensic Science International* (1997) 87, 185-192.
- 2.12.23** SWGDAM (2010). SWGDAM Interpretation Guidelines for Autosomal STR Typing by Forensic DNA Testing Laboratories. Available at <http://www.fbi.gov/about-us/lab/codis/swgdam.pdf>.
- 2.12.24** Clayton, T.M., Whitaker, J.P., Sparkes, R., Gill, P., Analysis and interpretation of mixed forensic stains using DNA STR profiling. *Forensic Science International* (1998) 91, 55-70.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

3 Forensic Relationship Comparison Methods

3.1 Scope

- 3.1.1** Forensic relationship comparisons may be requested as part of some criminal investigation cases. Types of relationship comparisons that can be performed include paternity, maternity, reverse paternity, sibling relationship (sibship), etc. These comparisons may establish potential relationships among individuals and/or aid in the identification of human remains and missing persons. Samples for forensic relationship testing shall be processed in accordance to the test methods outlined in the DNA methods section of this document.

3.2 Precautions/Limitations

- 3.2.1** Cases submitted for relationship comparisons should be evaluated by a member of the relationship comparison team before any testing is performed. It may be necessary to outsource some types of cases to a vendor laboratory for analysis. Cases shall be refused when they do not meet the requirements of forensic relationship comparison analysis.

3.3 Related Information

- 3.3.1** See Relationship Comparison Statistical Reference Sheet ([Appendix 8](#))

3.4 Instruments

- 3.4.1** See DNA Test Methods Section 2.4

3.5 Reagents/Materials

- 3.5.1** See DNA Test Methods Section 2.5

3.6 Hazards/Safety

- 3.6.1** See DNA Test Methods Section 2.6

3.7 Reference Materials/Controls/Calibration Checks

- 3.7.1** See DNA Test Methods Section 2.7

3.8 Procedures/Instructions

- 3.8.1** See DNA Test Methods Section 2.8

3.9 Interpretations of Relationship Testing Results

3.9.1 Possible Outcomes of Relationship Comparisons

- 3.9.1.1** The genetic profiles from standards and samples are compared to evaluate relationship. The following conclusions may be reported:

- 3.9.1.2** For parentage relationship cases:

- 3.9.1.2.1** The genetic results strongly support the hypothesis of the alleged relationship; therefore, the alleged individual cannot be excluded from the relationship. [Combined Parentage Index (CPI) >100]
- 3.9.1.2.2** The genetic results do not strongly support the hypothesis of the alleged relationship nor does it indicate no relationship; therefore, it is deemed inconclusive. An inconclusive result may also be derived if a genetic profile cannot be interpreted or is of poor quality. [100 > Combined Parentage Index (CPI) > 1]

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

3.9.1.2.3 The genetic results support the hypothesis of no relationship; therefore, the alleged individual can be excluded from the relationship. [Combined Parentage Index (CPI) <1]

3.9.1.3 For non-parentage relationship cases:

3.9.1.3.1 The genetic results support the hypothesis of the alleged relationship. [Combined Relationship Index (CRI) >10]

3.9.1.3.2 The genetic results do not strongly support the hypothesis of the alleged relationship nor does it indicate no relationship; therefore, it is deemed inconclusive. ($10 > \text{CRI} > 0.05$)

3.9.1.3.3 The genetic results support the hypothesis of no relationship. ($\text{CRI} < 0.05$)

3.9.2 Inconsistent Profiles In Parentage Relationship Cases

3.9.2.1 If the alleged father's profile is inconsistent with the child's profile at three or more loci, then no relationship/exclusion shall be concluded.

3.9.2.2 If the alleged father's profile is inconsistent with the child's profile at fewer than three loci, then other alternatives may be evaluated for these inconsistencies. Other alternatives may include possible mutation, null allele, first degree relative, or true exclusion. If it is determined that a possible mutation could account for the inconsistencies, then the mutation shall be included into the statistical calculations.

3.9.3 Mixtures

3.9.3.1 With product of conception/fetal samples, it is necessary to have a standard from the mother. Only loci where obligate paternal alleles can be determined shall be used for statistical purposes.

3.9.3.2 With personal effects believed to belong to a missing person, the degree of the mixture shall be evaluated to determine whether conclusive results can be obtained. Additional standards may be requested to aid in interpretation.

3.10 Rules for Relationship Statistical Calculations

3.10.1 Calculations shall be performed using the most current available version of Popstats (the version shall be documented in the case record), a computer software program designed by the FBI for statistical calculations.

3.10.2 Statistical calculations shall be calculated and reported in forensic relationship comparison cases where Results/Opinions/Interpretations are being given in regards to relationship. However, statistical calculations shall not be performed in parentage cases with conclusions of no relationship/exclusion.

3.10.3 See Relationship Comparison Statistical Reference Sheet ([Appendix 8](#)) for a list of formulas for calculations.

3.10.4 If more than one standard/sample is available for comparison, the most representative standard/sample or the standard/sample where the most obligate alleles can be determined shall be used for statistical calculations.

3.10.5 Relationship statistical calculations utilize the race of the alleged individual. The calculations shall be performed with the appropriate population data using the racial information provided by the contributing agency. If racial information is unknown or unobtainable, calculations shall be performed using each population group.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 3.10.6 Manual calculations performed by an analyst shall be re-calculated by a qualified technical reviewer and a qualified unit supervisor.
- 3.10.7 A Prior Probability (Pr) of 0.5 shall be used for all relationship calculations.
- 3.10.8 The Paternity Index for a locus demonstrating a possible mutation shall be calculated using the average locus mutation rate (μ) and the Probability of Exclusion (PE) determined by the obligate paternal allele.
- 3.10.9 All mutation rates are reported by AABB (American Association of Blood Banks), Standards for Relationship Testing Laboratories, 10th Edition, Appendix 6 (or the most current available edition).

3.11 Report Writing for Relationship Comparisons General Guidelines

- 3.11.1 The DNA profiles shall be reported in table format in the Results/Opinions/Interpretations area of the Certificate of Analysis. The Paternity Index for each locus, the Combined Paternity Index and the Probability of Paternity shall be reported in the table when applicable.
- 3.11.2 All reports shall include the required statement and retention statement listed in the DNA Methods report wording section.
- 3.11.3 The items used for comparison will be reported out in the format listed in the DNA Methods report wording section.
- 3.11.4 Alternate report wording may be used depending on the type of relationship and calculation performed.
- 3.11.5 Terminology of Parentage, Paternity, Maternity, Relationship, Kinship, and Sibling Relationship (Sibship) may be used interchangeably where applicable.
- 3.11.6 The Combined Paternity Index and the Paternity Index shall be reported as calculated by Popstats. However, any Popstats calculation of the Combined Paternity Index with a decimal value shall be rounded down to the nearest whole number.
- 3.11.7 The Probability of Paternity shall be reported to four decimal places. Statistical calculations shall be rounded to four significant figures for manual calculations.
- 3.11.8 Alternatively, the genetic results of the Amelogenin locus can also be reported in the table on the Certificate of Analysis when the gender of an individual may be meaningful.
- 3.11.9 Wording Of Relationship Comparisons For Results/Opinions/Interpretations are located in [Appendix 5](#).

3.12 Definitions

- 3.12.1 **Random Man Not Excluded (RMNE)** – The frequency of selecting a random man from the population that could not be excluded as the biological father.
- 3.12.2 **Probability of Exclusion/Power of Exclusion (PE)** – The probability of excluding a random man from the population as being the biological father; is dependent on the genotypes of the child and mother and the race of the alleged father.
- 3.12.3 **Parentage Index (PI)/Relatedness Index (RI)** – A likelihood ratio based on two different conditional probabilities; PI/RI is calculated for each locus in a system.
- 3.12.4 **Combined Parentage Index (CPI)/Combined Relatedness Index (CRI)** – CPI/CRI is the product of all PIs/RIs for the loci in a system; a measure of the strength of the genetic evidence.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 3.12.5 Probability of Parentage (W)** – Also known as the probability of relatedness. It is the measure of the strength of the genetic evidence and the non-genetic evidence that an individual is a biological relative as compared to an unrelated, random individual in the same population.
- 3.12.6 Prior Probability (Pr)** – The strength of the non-genetic evidence that the alleged individual is a biological relative.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

4 Y-STR Test Methods

4.1 Scope

Y-STR analysis may be performed in situations where male DNA needs to be differentiated from female DNA. DNA analysis performed prior to Y-STR analysis shall be in accordance to the test methods outlined in the DNA Methods section of this document.

4.2 Precautions/Limitations

4.2.1 Samples that may be suitable for Y-STR analysis should be evaluated by a member of the Y-STR team to determine the most appropriate sample(s) to analyze in a case. The following should be considered:

4.2.1.1 Standards from any male individuals involved in a case shall be submitted before Y-STR analysis is performed.

4.2.1.2 Cases that have not provided meaningful autosomal results should be considered for analysis.

4.2.1.3 Cases from sexual assault/misconduct should be considered for analysis.

4.2.1.3.1 Due to the limitations of the technology, property crimes generally will not be considered for analysis.

4.2.1.4 Samples with female to male ratios of greater than 10:1 should be considered for analysis.

4.3 Related Information

4.3.1 Worksheet Manual

4.4 Instruments

4.4.1 See DNA Test Methods Section 2.4

4.5 Reagents/Materials

4.5.1 See DNA Test Methods Section 2.5

4.6 Hazards/Safety

4.6.1 See DNA Test Methods Section 2.6

4.7 Reference Materials/Controls/Calibration Checks

4.7.1 See DNA Test Methods Section 2.7

4.8 Procedures/Instructions

4.8.1 See DNA Test Methods Section 2.8 for extraction procedures

4.8.1.1 Performing Y-STR analysis before or after autosomal STR analysis will be evaluated on a case by case basis.

4.8.1.2 Y-STR analysis may be performed on extracts previously used for autosomal STR testing or may require re-extraction of a sample.

4.8.1.3 Samples should be re-quantified using Quantifiler® Duo or Plexor® HY to get the most accurate quantification value (unless the case is being worked all the way through by the same analyst). The male quantification value shall be used for amplification of the sample. If the male quantity is zero (undetermined) using Quantifiler® Duo the sample may be amplified.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

4.8.2 Real-Time PCR Quantification for Y-STR Analysis Using Plexor® HY

4.8.2.1 Preparation Of The Quantification Plate

- 4.8.2.1.1 The Plexor® HY kit should be stored at -15 to -25°C. Once thawed, the Plexor® HY Male Genomic DNA Standard shall be stored at 2 to 8°C. Minimize the number of freeze-thaw cycles for the remaining kit components.
- 4.8.2.1.2 The preparation of the standard curve and the plate shall be performed in the PCR amplification set-up area.
- 4.8.2.1.3 The standard curve is stable for up to 2 weeks at 2 to 8°C.
- 4.8.2.1.4 **Prepare the Standard Curve**
 - 4.8.2.1.4.1 Thaw the Plexor® HY Male Genomic DNA Standard [50 ng/μl stock]. After initial thawing, store at 2 to 8 °C.
 - 4.8.2.1.4.2 Label seven microcentrifuge tubes Std. 2 through Std. 7.
 - 4.8.2.1.4.3 Dispense the required amount of TE⁻⁴ buffer to each tube. (See table below)
 - 4.8.2.1.4.4 Vortex the Plexor® HY Male Genomic DNA Standard for 5 seconds and add the specified amount to Std. 2 and mix thoroughly.
 - 4.8.2.1.4.5 Using a new pipette tip each time, continue diluting each successive concentration until the dilution series is complete.

Standard Curve	Dilution Series	Dilution Factor
Std. 1 [50.0 ng/μl]	50 ng/μl DNA stock	n/a
Std. 2 [10.0 ng/μl]	40 μl TE ⁻⁴ buffer + 10 μl 50 ng/μl DNA stock	5X
Std. 3 [2.0 ng/μl]	40 μl TE ⁻⁴ buffer + 10 μl Std. 2	5X
Std. 4 [0.4 ng/μl]	40 μl TE ⁻⁴ buffer + 10 μl Std. 3	5X
Std. 5 [0.08 ng/μl]	40 μl TE ⁻⁴ buffer + 10 μl Std. 4	5X
Std. 6 [0.016 ng/μl]	40 μl TE ⁻⁴ buffer + 10 μl Std. 5	5X
Std. 7 [0.0032 ng/μl]	40 μl TE ⁻⁴ buffer + 10 μl Std. 6	5X

4.8.2.1.5 Prepare the Reactions

- 4.8.2.1.5.1 Each plate shall contain a standard curve series run in duplicate and at least one Non-Template Control (NTC).
- 4.8.2.1.5.2 Determine the number of samples to be quantified, including standards and the non-template control(s). Add 3 to 5 reactions to this number to compensate for the loss that occurs during reagent transfers.
- 4.8.2.1.5.3 Using the Plexor® HY worksheet, calculate the required amount of each component of the master mix. Multiply the volume per reaction (μl) by the total number of reactions.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

PCR Master Mix Component	Volume per Reaction (µl) (assumes 2 µl template per reaction)
Plexor® HY 2X Master Mix	10.0 µl
Water, Amplification Grade	7.0 µl
Plexor® HY 20X Primer/IPC Mix	1.0 µl
Total Volume	18.0 µl

- 4.8.2.1.5.4 Thaw the Plexor® HY 2X Master Mix, Plexor® HY 20X Primer/IPC Mix, and Water, Amplification Grade.
- 4.8.2.1.5.5 Vortex the 2X Master Mix and 20X Primer/IPC Mix for 3 to 5 seconds. Do not centrifuge as this may cause primers to be concentrated at the bottom of the tube.
- 4.8.2.1.5.6 Combine the required volumes of Water, Amplification Grade, 2X Master Mix, and 20X Primer/IPC Mix into a microcentrifuge tube.
- 4.8.2.1.5.7 Vortex briefly to mix and centrifuge.
- 4.8.2.1.5.8 Dispense 18 µl of the Master Mix into each reaction well of a 96-well optical plate.
- 4.8.2.1.5.9 Add 2 µl of sample, standard, or Non-Template Control (TE⁻⁴) to the appropriate wells.
- 4.8.2.1.5.10 Seal the reaction plate with an Optical Adhesive Cover. Run the edge of the cover applicator between the rows and columns of the wells to ensure that all wells are sealed properly.
- 4.8.2.1.5.11 Spin the plate using either a centrifuge or a salad spinner to remove any bubbles and force samples into the bottom of each well.

4.8.2.2 Create Plate Document and Run Plate (Note: The plate document shall be created and saved on the computer prior to running the quantification plate on the instrument.)

- 4.8.2.2.1 Turn on the computer.
- 4.8.2.2.2 Turn on the Real-Time PCR instrument (must be on prior to opening the software).
- 4.8.2.2.3 Open the Applied Biosystems® 7500 System Sequence Detection Software v 1.2.3.
- 4.8.2.2.4 Set up the Plate Document as described below: File ⇒ New

Assay: Absolute Quantification (Standard Curve)
 Container: 96-Well Clear
 Template: Plexor Y
 Operator: your name
 Plate Name: "First case on plate_date_plate#" ex. "00A1234_01Jan11_01"
- 4.8.2.2.5 Click Finish.
- 4.8.2.2.6 Ensure that detectors (Autosomal, IPC and Y) are selected only for wells that are being used. Including unused wells will significantly impact the scale of the X and Y axes when viewing the data.
- 4.8.2.2.7 Sample names should be added later within the Plexor® Analysis Software.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION


TEST METHODS

- 4.8.2.2.8 Save the plate document at this time.
- 4.8.2.2.9 Place the plate in the instrument.
- 4.8.2.2.10 Select the **Instrument** tab of the plate document and click “Start”.
- 4.8.2.2.11 When the run is finished, click “Okay”.


4.8.2.3 Analyze the Plate

- 4.8.2.3.1 In the SDS software, analyze the plate by clicking the Green Arrow (►) on the toolbar or select Analysis ⇒ Analyze.
- 4.8.2.3.2 To export the amplification data, select File ⇒ Export ⇒ Delta RN. Save the .csv file with an appropriate name (First case on plate_date_plate#_DeltaRn).
- 4.8.2.3.3 To export the melt/dissociation data, select File ⇒ Export ⇒ Dissociation ⇒ Raw and Derivative Data. Save the .csv file with an appropriate name (First case on plate_date_plate#_melt). **Note:** When a dissociation curve is included in a thermal cycling program, the SDS software may expect SYBR® green as the dye choice. A message will appear when analyzing an experiment. Select “Yes” and continue.

4.8.2.4 Data Import into the Plexor® Analysis Software

- 4.8.2.4.1 To launch the Plexor® Analysis Software (forensic release) go to the Start menu ⇒ All Programs ⇒ Plexor. A shortcut can be placed on the desktop by going to the Start menu ⇒ Programs, then right-click on Plexor ⇒ Create Shortcut.
- 4.8.2.4.2 In the File menu, deselect “Set Passive Reference On Import”.
- 4.8.2.4.3 In the File menu, select “Import New Run”, or select the icon: 
- 4.8.2.4.4 Select “Applied Biosystems® 7500 SDS v1.4 & prior” as the instrument type.
- 4.8.2.4.5 Select “Add Target” three times. For each dye, assign a target name, enter the correct dye name (FL for Autosomal, CO560 for Y and CR610 for IPC) and indicate that there are amplification data and melt (dissociation) data to be analyzed for each dye.
- 4.8.2.4.6 Select “Next”.
- 4.8.2.4.7 Enter Operator Name.
- 4.8.2.4.8 Select “Next”.
- 4.8.2.4.9 Use “Browse” on the File Import Screen to specify the amplification and dissociation/melt data files previously exported from the instrument.
- 4.8.2.4.10 Select “Finish” to complete the data import and open the Analysis Desktop.




4.8.2.5 Data Analysis with Plexor® Analysis Software

- 4.8.2.5.1 Sample Definition.
 - 4.8.2.5.1.1 Define the DNA standards.
 - 4.8.2.5.1.1.1 Select the **PCR Curves** tab and use the well selector to highlight the wells that contain the DNA standards.
 - 4.8.2.5.1.1.2 Select the Dilution Series icon: .

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION


TEST METHODS

- 4.8.2.5.1.1.3 Confirm that the series selected is the “Vertical Series” and the series is “Decreasing”. Enter 50 for the starting concentration and 5 for the dilution factor.
- 4.8.2.5.1.1.4 Select “Apply”.
- 4.8.2.5.1.2 Define the Non-Template Control reactions.
 - 4.8.2.5.1.2.1 Select the **PCR Curves** tab and use the well selector to highlight the wells that contain NTC reactions.
 - 4.8.2.5.1.2.2 Select the NTC icon: .
- 4.8.2.5.1.3 Assign Sample Names
 - 4.8.2.5.1.3.1 Select the **Sample IDs** tab.
 - 4.8.2.5.1.3.2 Select the well and enter the desired sample name for each sample. Each sample shall be uniquely identified.
 - 4.8.2.5.1.3.3 Select “Accept Changes”.
- 4.8.2.5.2 Adjust Target Melt Temperature.
 - 4.8.2.5.2.1 Select the **PCR Curves** tab.
 - 4.8.2.5.2.2 Change the autosomal melt temperature range by clicking on the blue shaded area on the graph (default temperature is set at 90.0).
 - 4.8.2.5.2.3 In the **melt curves** window, move the mouse so that the arrow is over the expected melt temperature line and drag the range to approximately the middle of the melt curves.
 - 4.8.2.5.2.4 Repeat for Y and IPC by choosing the appropriate **PCR Curves** tab.
- 4.8.2.5.3 Standard Curves and Sample Concentrations
 - 4.8.2.5.3.1 To generate the autosomal standard curve, select the **Autosomal** tab in the **PCR Curves** tab and select the standards in the well selector.
 - 4.8.2.5.3.2 Select the Add Standard Curve icon: .
 - 4.8.2.5.3.3 Select the **Y** tab in the **PCR Curves** tab and repeat to generate the Y standard curve.
 - 4.8.2.5.3.4 To view the standard curves, select the **Standard Curves** tab.
 - 4.8.2.5.3.5 To print the autosomal and Y standard curves, select “Print a Screenshot” from the File menu.
 - 4.8.2.5.3.6 Examine the autosomal and Y standard curves. (See Interpretation Guidelines for Plexor® HY Real-time PCR Quantification for further evaluation of the standard curves.)
 - 4.8.2.5.3.7 To obtain autosomal quantification values for all samples, select the **Autosomal** tab in the **PCR Curves** tab and select all samples and standards in the well selector.
 - 4.8.2.5.3.8 Select the Add Standard Curve icon: .

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 4.8.2.5.3.9 Select the **Y** tab in the **PCR Curves** tab and repeat to obtain the Y quantification values for all samples.
- 4.8.2.5.4 Generate Forensic Report (without normalization).
 - 4.8.2.5.4.1 In the Forensic Menu, select “Normalization and IPC Parameters”.
 - 4.8.2.5.4.2 Check the “disable volume normalization (show concentrations and Cq values only)” box.
 - 4.8.2.5.4.3 Select the **Internal PCR Control (IPC)** tab and change the IPC threshold value to 0.7.
 - 4.8.2.5.4.4 Select “OK”.
 - 4.8.2.5.4.5 Select the **Reports** tab and then the **Forensics** tab to view results.
 - 4.8.2.5.4.6 Select all samples in the Forensic Report table and right click on the outside of the table.
 - 4.8.2.5.4.7 Select “Change Columns Shown” and check the “IPC Observed Cq” and the “IPC Expected Cq” boxes.
 - 4.8.2.5.4.8 Check for inhibition of samples by evaluating the IPC Status and IPC values on the Forensic Report.
 - 4.8.2.5.4.8.1 The IPC status indicates if the difference between the sample’s C_T for the IPC and the DNA standard is greater than the 0.7. A difference of less than 0.7 is indicated as “OK” while a difference greater than 0.7 is indicated as “Check IPC”.
 - 4.8.2.5.4.9 Check the “Curves Status” for the samples on the Forensic Report.
 - 4.8.2.5.4.9.1 “OK” indicates the following:
 - 4.8.2.5.4.9.1.1 The sample, if defined as a standard, shows amplification.
 - 4.8.2.5.4.9.1.2 The sample, if defined as a non-template control, shows no amplification.
 - 4.8.2.5.4.9.1.3 If a melt peak is present, the T_m is within the expected range.
 - 4.8.2.5.4.9.2 “Check STD”, “Check NTC”, or “Check Melts” will be displayed if the above criteria or not met.
 - 4.8.2.5.4.10 Print Forensic Report.
 - 4.8.2.5.4.10.1 Select all samples in the Forensic Report.
 - 4.8.2.5.4.10.2 Select the Export Selected icon: .
 - 4.8.2.5.4.10.3 Save the .tab file with an appropriate name (First case on plate_date_plate#_ForensicReport).
 - 4.8.2.5.4.10.4 Open the .tab file using Microsoft Excel and print Forensic Report.
- 4.8.2.5.5 Save the analysis file (.aan) with an appropriate name (First case on plate_date_plate#) by selecting “Save Analysis File (.aan)” in the File menu.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 4.8.2.5.6 Save required data under each associated laboratory case number and request folder located in the analysts' folders on the server. The required data include the Applied Biosystems® 7500 System Sequence Detection Software .sds file, the exported amplification and melt/dissociation data (.csv), the Plexor® Analysis Software Forensic Report (.tab), and the Plexor® Analysis Software Analysis File (.aan).
- 4.8.2.5.7 At a minimum the required documents for the case record shall be generated. The required documents include the exported Microsoft Excel Forensic Report, the autosomal standard curve and the Y standard curve.

4.8.2.6 Interpretation Guidelines for Plexor® HY Real-Time PCR Quantification

4.8.2.6.1 Controls

4.8.2.6.1.1 **Standard Curve:** The purpose of the standard curve is to evaluate the quality of the results from the quantification standard reactions.

4.8.2.6.1.1.1 **Slope:** Indicates the PCR amplification efficiency for the assay. A slope of -3.3 indicates 100% amplification efficiency. Scientific rounding rules apply. The analyst shall obtain documented Technical Leader approval to use data when the slope is outside the accepted range.

	Range
Plexor® HY Autosomal	-3.1 to -3.7
Plexor® HY Y	-3.0 to -3.6

4.8.2.6.1.1.2 **R² value:** a measure of the closeness of fit between the standard curve regression line and the individual C_T data points of the quantification standard reactions. A value of 1.00 indicates a perfect fit between the regression line and the data points. This value shall be ≥ 0.98. If the R² value is <0.98 the test is inconclusive and should be repeated. The Technical Leader shall be notified with documentation in the case record.

4.8.2.6.1.1.3 **Y Intercept:** indicates the expected C_T value for a sample with Quantity = 1 (i.e. 1 ng/μl). The analyst shall obtain documented Technical Leader approval to use data when the Y-intercept value is outside of the acceptable range.

	Range
Plexor® HY Autosomal	22 to 25
Plexor® HY Y	23 to 26

4.8.2.6.1.1.4 Occasionally there will be an outlier data point on the standard curve. Low R² values (<0.98) may be due to variability for replicate samples of the 0.0032 ng/μl dilution. The 0.0032 ng/μl standard may show increased variability compared to the other dilutions, most notably in autosomal reactions. The

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

0.0032 ng/μl standard(s) may be removed from the autosomal and/or Y standard curves by changing the standard(s) to “unknown”.

4.8.2.6.1.1.5 One other data point in addition to the 0.0032 ng/μl standard(s) may be removed from each standard curve. The analyst shall have documented supervisor approval to omit additional points in the standard curve(s). The Technical Leader shall be notified with documentation in the case record.

4.8.2.6.1.2 **Non-Template Control (NTC):** Contains PCR reagent, but no template DNA. Occasionally, a value may be given for the NTC due to background fluorescence. The analyst may proceed with amplification and typing of the samples using caution with interpretation of any profiles obtained from the samples.

4.8.2.6.1.3 **Internal PCR Control (IPC):** The purpose of the IPC is to distinguish between a true negative sample result and reactions affected by the presence of PCR inhibitors, assay setup, and/or chemistry/instrument failure.

4.8.2.6.1.3.1 An inhibition check can be done by comparing IPC C_T values for unknown samples with IPC C_T values for DNA standards. The set IPC threshold is 0.7 cycles. If a sample's IPC C_T value is more than 0.7 cycles greater than a comparable standard, there may be an indication of inhibition by the sample. High levels of total human DNA (>10 ng/μl) may cause a slight delay (1 – 2 cycles) the IPC crossing the cycle threshold. Given this information, an analyst may choose to dilute, Microcon® and/or Centri-sep the sample prior to amplification and typing.

4.8.2.6.1.3.2 An undetected IPC C_T may also be an indication of inhibition. The analyst may choose to dilute, Microcon® and/or Centri-sep the sample before continuing with analysis. It is at the discretion of the analyst whether or not to continue processing a sample in which the IPC is undetected. If the sample is not carried throughout the testing process, it shall be reported out as inconclusive.

4.8.2.6.2 Amplification/Melt Curves

4.8.2.6.2.1 If “Check STD” is displayed for the Curves Status, ensure the standard curve has been properly generated. See Sections 4.8.2.6.1.1.4 and 4.8.2.6.1.1.5 for deleting points from the standard curve(s).

4.8.2.6.2.2 If “Check NTC” is displayed in the Curves Status and the NTC has a value, the samples may be amplified (see Section 4.8.2.6.1.2).

4.8.2.6.2.3 If “Check Melts” is displayed in the Curves Status or the melt curve for a sample is not within the expected range, the sample shall still be amplified. A shift in the melt curve may indicate non-specific amplification, primer dimers, or contaminant DNA.

Target	T_m Range
Autosomal	79-81°C

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

Y	81-83 °C
IPC	79-81° C

The IPC T_m value can fall as much as 2 °C outside the normal range. The default target range is $T_m \pm 1.5$ °C.

4.8.2.6.2.4 A “No Call” for the T_m indicates that the melt curve displays the expected melt temperature, but there is insufficient amplification product to cause the melt curve to cross the melt threshold. If the amount of male DNA present exceeds the set threshold, additional Y-STR analysis of the sample shall be performed.

4.8.2.6.2.5 It is acceptable for the 0.0032 ng/μl DNA standard to display “No” or “No Call” in the “ T_m ?” column. Verify that if any subthreshold peak is present in the melt curve, this peak is within the expected target melt temperature range.

4.8.2.6.3 Dynamic Range

4.8.2.6.3.1 If the quantity of male DNA detected in the sample is below 0.003 ng/μl, no additional Y-STR analysis of that sample shall be performed.

4.8.2.6.3.2 If the quantity of male DNA in a sample is > 50 ng/μl, dilutions shall be made and re-quantified if they are to be amplified.

4.8.2.6.3.3 Quantification values from the Y target shall be used for amplification of Y-STR's.

4.8.2.6.3.4 Because the quantification values may have many significant figures, the analyst may truncate the value to one digit past the decimal point, but only after the value has been multiplied by 5 for amplification. (i.e. $1A = 1.59 \text{ ng/}\mu\text{l} \times 5 \mu\text{l} = 7.95 \text{ ng/}5 \mu\text{l} = 7.9$).

4.8.3 PowerPlex® Y23 Introduction (Applied Biosystems® 3500 Genetic Analyzer)

4.8.3.1 Short tandem repeat (STR) markers on the Y chromosome (Y-STR) have qualities that are distinct from autosomal markers and are useful for human identification. The Promega PowerPlex® Y23 System allows co-amplification and four-color detection of twenty-three loci. The amplification occurs in a single reaction tube and detection occurs by a single capillary electrophoresis injection.

4.8.3.2 The Applied Biosystems® 3500 Genetic Analyzer utilizes electrokinetic injection of DNA molecules into polymer-filled capillaries which separates the DNA fragments by size. The fluorescent tag labeled primers incorporated into the PowerPlex® Y23 amplification products are responsive to the frequency of the 20 mW solid state laser. Upon excitation, the fluorophores are raised to a higher energy level. When the fluorophores return to their normal energy level, a fluorescent signal is emitted. This signal is then detected by a camera within the 3500 capillary electrophoresis instrument which converts the signal to a computer image where it is visualized in an electropherogram as a peak.

4.8.3.3 The data produced by the Applied Biosystems® 3500 Genetic Analyzer is analyzed with GeneMapper® ID-X Software which results in peaks labeled with their allele designation. The CC5 Internal Lane Standard 500 Y23 (CC5 ILS 500 Y23) is injected with each sample and it contains 21 fragments of 60, 65, 80, 100, 120, 140,

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

160, 180, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, and 500 bases in length. Each fragment is labeled with CC5 dye and can be detected separately (as a fifth color) in the presence of PowerPlex® Y23 amplified material. The CC5 ILS 500 Y23 determines the base pair size of the fragments in the sample and the software compares the sizes to an allelic ladder to determine the allele designation.

The PowerPlex® Y23 System Locus-Specific and Allelic Ladder Information

STR Locus	Chromosomal Location ¹	Repeat Sequence ² 5'→3'	Label	Size Range of Allelic Ladder Components ^{3,4} (bases)	Repeat Numbers of Allelic Ladder Components ⁵
DYS576	Y	AAAG	Fluorescein	97-145	11-23
DYS389 I	Y	(TCTG) (TCTA)	Fluorescein	147-179	9-17
DYS448	Y	AGAGAT	Fluorescein	196-256	14-24
DYS389 II	Y	(TCTG) (TCTA)	Fluorescein	259-303	24-35
DYS19	Y	TAGA	Fluorescein	312-352	9-19
DYS391	Y	TCTA	JOE	86-130	5-16
DYS481	Y	CTT	JOE	139-184	17-32
DYS549	Y	GATA	JOE	198-238	7-17
DYS533	Y	ATCT	JOE	245-285	7-17
DYS438	Y	TTTTC	JOE	293-343	6-16
DYS437	Y	TCTA	JOE	344-380	11-18
DYS570	Y	TTTC	TMR-ET	90-150	10-25
DYS635	Y	TSTA compound	TMR-ET	150-202	15-28
DYS390	Y	(TCTA) (TCTG)	TMR-ET	207-255	17-29
DYS439	Y	AGAT	TMR-ET	263-307	6-17
DYS392	Y	TAT	TMR-ET	314-362	4-20
DYS643	Y	CTTTT	TMR-ET	368-423	6-17
DYS393	Y	AGAT	CXR-ET	101-145	7-18
DYS485	Y	GAAA	CXR-ET	159-215	10-24
DYS385 a/b	Y	GAAA	CXR-ET	223-307	7-28
DYS456	Y	AGAT	CXR-ET	316-364	11-23
Y-GATA-H4	Y	TAGA	CXR-ET	374-414	8-18

¹Information about most of these loci can be found at: www.cstl.nist.gov/biotech/strbase/chrom.htm

²The August 1997 report (30,31) of the DNA Commission of the International Society for Forensic Haemogenetics (ISFH) states, "1) for STR loci within coding genes, the coding strand shall be used and the repeat sequence motif defined using the first possible 5' nucleotide of a repeat motif; and 2) for STR loci not associated with a coding gene, the first database entry or original literature description shall be used".

³The length of each allele in the allelic ladder has been confirmed by sequence analysis.

⁴When using an internal lane standard, such as the CC5 Internal Lane Standard 500 Y23, the calculated sizes of allelic ladder components may differ from those listed. This occurs because different sequences in allelic ladder and ILS components may cause differences in migration. The dye label also affects migration of alleles.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

⁵For a current list of microvariants, see the Variant Allele Report published at the U.S. National Institute of Standards and Technology (NIST) web site at: www.cstl.nist.gov/div831/strbase/ and the Y Chromosome Haplotype Reference Database at: www.yhrd.org

4.8.4 PowerPlex® Y23 Amplification Set-Up (Note: The following steps shall be performed in the PCR amplification set-up area.)

- 4.8.4.1** Thaw the Amplification Grade Water, PowerPlex® Y23 5X Master Mix, and PowerPlex® Y23 10X Primer Pair Mix. When thawed, it is important to vortex the PowerPlex® Y23 5X Master Mix and PowerPlex® Y23 10X Primer Pair Mix tubes for 5 to 10 seconds. (Do not centrifuge after vortexing as this may cause the primers/dNTPs to be concentrated at the bottom of the tube.) The Amplification Grade Water may be stored at 2-10° C for extended periods.
- 4.8.4.2** Determine the number of samples to be amplified, including controls (reagent blank, a positive control [PC], and an amplification blank [AB]). Add 2 to 4 reactions to this number to compensate for the loss that occurs during reagent transfers.
- 4.8.4.3** Place one 0.2 ml reaction tube for the Model 9700 Thermal Cycler for each sample into a rack, label appropriately.
- 4.8.4.4** 0.05 ng to 0.5 ng of template DNA is recommended. Amplification of greater than 0.5 ng of template DNA should not be used due to off-scale peak heights and may result in increased artifacts and interfere with interpretation. Targeting less than 0.5 ng of template DNA should be used only with samples whose concentration falls between 0.003 ng/μl and 0.029 ng/μl. Such samples shall be interpreted with caution. Samples with concentrations greater than 0.029 ng/μl should target 0.5 ng but shall not exceed 1.0 ng for amplification.
- 4.8.4.5** Using the Master Mix worksheet, calculate the required amount of each component of the PCR master mix. Multiply the volume (μl) per sample by the total number of reactions (from 4.8.4.2) to obtain the final volume (μl).

Components of Master Mix/sample:

12.5 μl Nuclease Free Water or Amplification Grade Water

5.0 μl PowerPlex® Y23 5X Master Mix

2.5 μl PowerPlex® Y23 10X Primer Pair Mix

20μl Total Volume (w/o sample)

- 4.8.4.6** Add the calculated volume of each component to a 1.5 ml tube. Mix gently.
- 4.8.4.7** Add 20 μl of PCR master mix to each sample tube using a positive displacement pipettor or a repeat pipettor.
- 4.8.4.8** Pipette 5.0 μl of each sample into the respective tube containing Master Mix.
- 4.8.4.9** For samples requiring more than 5 μl of sample volume, use the variable PPY23 Amplification Worksheet to calculate the required amount for each component of the PCR master mix. Sample volumes above 5 μl shall be subtracted from the nuclease free or amplification grade water volume in the master mix.

4.8.4.9.1 Components of the Master Mix/sample:

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

Up to 12.5 µl Nuclease Free or Amplification Grade Water

5 µl PowerPlex® Y23 5X Master Mix

2.5 µl PowerPlex® Y23 10X Primer Pair Mix

Between 7.5 and 20 µl Total Volume (without sample)

- 4.8.4.10** Add the calculated volume of each component to a 1.5 ml tube. Mix gently.
- 4.8.4.11** Add up to 20 µl of PCR master mix to each sample tube or well using a positive displacement pipettor or a repeat pipettor.
- 4.8.4.12** Pipette the appropriate amount of each sample (up to 17.5 µl) into the respective tube containing master mix. For organic extractions if the template DNA is stored in TE buffer, the volume of the DNA sample added should not exceed 20% of the final reaction volume. PCR amplification efficiency and quality can be greatly altered by changes in pH (due to added Tris-HCl) or available magnesium concentration (due to chelation by EDTA). DNA samples stored (or diluted) in NFH₂O are not subject to this caution, but may contain other PCR inhibitors at low concentrations depending on the source of the template DNA and the extraction procedure employed.
- 4.8.4.13** For the positive control, dilute the 2800M or other approved positive DNA standard supplied with the PowerPlex® Y23 kit to 0.02ng/µl to 0.1ng/µl. Pipette 5.0µl (0.1 ng to 0.5ng) of diluted male DNA into a 0.2 µl reaction tube containing 20 µl of PCR master mix. A positive control shall be included in each thermal cyclor. (NOTE: The positive control should be stored at 2-10°C).
- 4.8.4.14** For the negative amplification control, pipette 5.0µl of nuclease free or amplification grade water into a 0.2 µl reaction tube containing 20µl of the PCR master mix. A negative amplification control shall be included in each thermal cyclor.

4.8.5 PowerPlex® Y23 Amplification

- 4.8.5.1** Assemble the tubes in a thermal cyclor.
- 4.8.5.2** Select and run the thermal cycling protocol below:
- 4.8.5.3 Applied Biosystems® GeneAmp® 9700 Thermal Cyclor**

96°C for 2 minutes, then:

94°C for 10 seconds

61°C for 1 minute

72°C for 30 seconds

for **30 cycles**, then:

60°C for 20 minutes, then:

Soak at 4°C until the tubes are removed

- 4.8.5.4** Select 25 µl for the volume in the amp tubes.
- 4.8.5.5** Select Max mode for the ramp speed.
- 4.8.5.6** Remove samples after the amplification process is completed.
- 4.8.5.7** Store amplified samples in the freezer. Amplified samples may be stored in the refrigerator if they are to be used within two days.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

4.8.6 Applied Biosystems® 3500 Genetic Analyzer - Data Collection Software version 2.0 - Instrument (only necessary the first time PowerPlex® Y23 samples are run or if the parameters change.)

4.8.6.1 See DNA Test Methods 2.8.13 for security, user roles, and user account settings.

4.8.6.2 Create an Instrument Protocol

- 4.8.6.2.1 Navigate to the library and select “Instrument Protocols”.
- 4.8.6.2.2 Select “Create”.
- 4.8.6.2.3 Select “HID” for the Application Type.
- 4.8.6.2.4 Select “36” for the Capillary Length.
- 4.8.6.2.5 Select “POP4” for the Polymer.
- 4.8.6.2.6 Select “Promega G5” for the Dye Set.
- 4.8.6.2.7 Select “HID36_POP4” for the Run Module.
- 4.8.6.2.8 Enter the desired Injection Time and Injection Voltage.
- 4.8.6.2.9 Change the run time to 1500 seconds.
- 4.8.6.2.10 Name the protocol with the kit name and the injection voltage and time (ex.PPY23_3kV3s).
- 4.8.6.2.10.1 Instrument protocols shall be created for 3kV3s and 3kV8s.

Instrument Protocol:

The screenshot shows the 'Edit Instrument Protocol PPY23_3kV3s' window. The title bar includes a question mark icon and a close button. The main area is titled 'Setup an Instrument Protocol' and contains several sections:

- Application Type:** HID (dropdown)
- Capillary Length:** 36 (dropdown) cm
- Polymer:** POP4 (dropdown)
- Dye Set:** Promega G5 (dropdown)
- Instrument Protocol Properties:**
 - * Run Module:** HID36_POP4 (dropdown)
 - * Protocol Name:** PPY23_3kV3s (text field) with a 'Locked' checkbox.
 - Description:** (empty text field)
- Parameters:**
 - Oven Temperature (°C): 60
 - Run Voltage (kVolts): 15.0
 - PreRun Voltage (kVolts): 15
 - Injection Voltage (kVolts): 3
 - Run Time (sec.): 1500
 - PreRun Time (sec.): 180
 - Injection Time (sec.): 3
 - Data Delay (sec.): 1
- Advanced Options:** (expandable section)

At the bottom, there are 'Close' and 'Save' buttons.

- 4.8.6.2.11 Click the “Save” button.

4.8.6.3 Create a Size Standard

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 4.8.6.3.1 Navigate to the Library and select “Size Standard”.
- 4.8.6.3.2 Select “Create”.
- 4.8.6.3.3 Assign the name “PPY23_ILS500”.
- 4.8.6.3.4 Select “Orange” for the Dye Color.
- 4.8.6.3.5 Type the following into the left column: 60, 65, 80, 100, 120, 140, 160, 180, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, and 500. Click “Add Size(s)”.
- 4.8.6.3.6 Click “Save”.

Size Standard:

Edit Size Standard PPY23_ILS500

View a Size Standard

* Size Standard: PPY23_ILS500 ☒ Locked

Description: 60-to-500

* Dye Color: Orange

Enter sizes in the field below separated by a comma, space, or return then click the "Add Size(s)" >> button to add them to the current size standard definition.

Enter new Size Standard definition: (e.g. 11.0, 34.2, 55)

* Current Size Standard definition: Delete Selected Sizes

60.0
65.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
225.0
250.0
275.0
300.0
325.0
350.0

Add Size(s) >>

Close Save

4.8.6.4 Create a QC Protocol

- 4.8.6.4.1 Navigate to the Library and select “QC Protocols”.
- 4.8.6.4.2 Select “Create”.
- 4.8.6.4.3 Assign the name “PPY23_ILS500”.
- 4.8.6.4.4 Change settings to match the figure below.

QC Protocol:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Edit QC Protocol PPY23_ILS500

Setup a QC Protocol

* Protocol Name: PPY23_ILS500 ☒ Locked

Description:

Size Standard: PPY23_ILS500

Sizecaller: SizeCaller v1.1.0

Analysis Settings **QC Settings**

Analysis Range: Full

Analysis Start Point: 0

Analysis Stop Point: 1000000

Sizing Range: Partial

Sizing Start Size: 60

Sizing Stop Size: 500

Size Calling Method: Local Southern

Peak Amplitude Threshold

Blue	Green	Yellow	Red	Purple	Orange
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
75	75	75	75	175	75

Common Settings

Use Smoothing: Light

Use Baseline (Baseline Window (Pts)) ☒ 51

Minimum Peak Half Width: 2

Peak Window Size: 15

Polynomial Degree: 3

Slope Threshold Peak Start: 0.0

Slope Threshold Peak End: 0.0

Close Save

4.8.6.4.5 Click "Save".

4.8.6.5 Create an Assay

- 4.8.6.5.1 Navigate to the Library and Select "Assays".
- 4.8.6.5.2 Select "Create".
- 4.8.6.5.3 Assign a descriptive assay name (ex. PPY23_3kV3s).
- 4.8.6.5.4 Select "HID" for the Application Type.
- 4.8.6.5.5 Select "PPY23_ILS500" as the QC Protocol.
- 4.8.6.5.6 Select the appropriate instrument protocol created in 4.8.6.2.

Assay:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Edit Assay PPY23_3kV3s

Setup an Assay

* Assay Name: PPY23_3kV3s ☒ Locked Color: Green

Application Type: HID

Protocols

Do you wish to assign multiple instrument protocols to this assay? ☒ No ☐ Yes

* Instrument Protocol: PPY23_3kV3s

* QC Protocol: PPY23_ILS500

GeneMapper IDX Protocol:

4.8.6.5.7 Click "Save".

4.8.6.5.7.1 An assay shall be created for each instrument protocol.

4.8.6.5.7.2 If multiple instrument protocols need to be run on the same samples an assay shall be created for that combination of protocols.

4.8.6.5.7.3 Follow steps 4.8.6.5.1 to 4.8.6.5.6.

4.8.6.5.7.4 Select "Yes" to assign multiple instrument protocols to this assay.

4.8.6.5.7.5 Select each desired instrument protocol and click "Add to List".

4.8.6.5.7.6 Click "Save".

Assay – Multiple Injections:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Edit Assay PPY23_3kV3s_3kV8s

Setup an Assay

* Assay Name: PPY23_3kV3s_3kV8s ☒ Locked Color: Red

Application Type: HID

Protocols

Do you wish to assign multiple instrument protocols to this assay? ☐ No ☒ Yes

Instrument Protocols

Available Library: PPY23_3kV3s

Instrument Protocols:

2 Instrument Protocol(s) Assigned to this Assay

NOTE: Order the list of protocols in the order you want them injected

Injection	Instrument Protocol
1	PPY23_3kV3s
2	PPY23_3kV8s

* QC Protocol: PPY23_ILS500

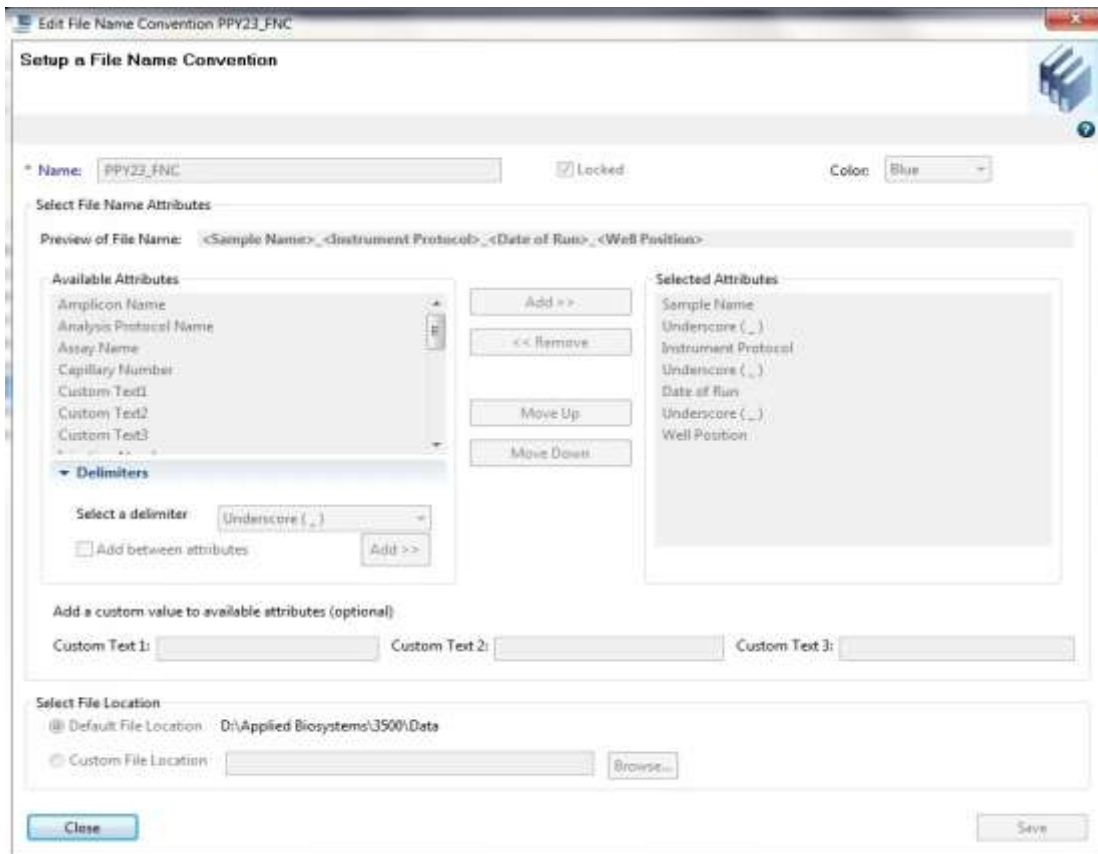
GeneMapper IDX Protocol:

4.8.6.6 Create a Naming Convention

- 4.8.6.6.1 Navigate to the Library and Select "File Name Convention".
- 4.8.6.6.2 Select "Create".
- 4.8.6.6.3 Assign a descriptive name (ex. PPY23_FNC).
- 4.8.6.6.4 Select desired attributes and click "Add".
- 4.8.6.6.5 Select desired delimiters and click "Add".
- 4.8.6.6.6 Leave file location as the default.
- 4.8.6.6.7 Look at the "Preview of File Name" field for accuracy and Click "Save".

File Name Convention:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



4.8.6.7 Create a Results Group

- 4.8.6.7.1 Navigate to the Library and Select “Results Group”.
- 4.8.6.7.2 Select “Create”.
- 4.8.6.7.3 Assign a descriptive assay name (ex. PPY_ResultsGroup).
- 4.8.6.7.4 Select the desired attributes and click “Add”.
- 4.8.6.7.5 Select the desired delimiters, click the “Add between attributes” box and click “Add”.
 - 4.8.6.7.5.1 The order of the attributes and delimiters can be changed using the “Move Up” and “Move Down” buttons.
- 4.8.6.7.6 Ensure that “Store reinjection sample file with original sample files (same level)” is selected.
- 4.8.6.7.7 Leave file location as the default.
- 4.8.6.7.8 Click so the “Include a Result Group Name folder” box is selected.
- 4.8.6.7.9 Look at the “Preview of “Results Group Name” field for accuracy and Click “Save”.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Results Group:

Edit Results Group PPY_ResultsGroup

Setup a Results Group

Name: PPY_ResultsGroup Locked Color: Dark Magenta

Select Results Group Attributes

Preview of Results Group Name: <Plate Name>

Available Attributes:

- Assay Name
- Injection Number
- Definers

Select a delimiter: Dash (-) Add >>

Add between attributes

Selected Attributes:

- Plate Name

Buttons: Add >>, << Remove, Move Up, Move Down

Enter a custom value as either the Prefix or Suffix (optional)

Prefix: Suffix:

Select Reinjection Folder Option

- ☐ Store reinjection sample files in a separate Reinjection folder (same level as Injection folders)
- ☒ Store reinjection sample files with original sample files (same level)

Select Folder Option

Default file location: D:\Applied Biosystems\3500\Data\<Plate Name>\

Custom file location: Browse...

Include an Instrument Run Name folder

☒ Include a Result Group Name folder

☐ Include an Injection folder

Close Save

4.8.7 Applied Biosystems® 3500 Genetic Analyzer - Data Collection Software version 2.0 - PowerPlex® Y23 Electrophoresis

4.8.7.1 Sample Preparation

- 4.8.7.1.1 **Note:** The quality of formamide is critical for the successful detection of a DNA profile. Deionized formamide shall be used that has a conductivity of less than 100µS/cm, such as Hi-Di™ Formamide. The formamide shall be frozen in aliquots at -20°C and the remainder of each aliquot shall be discarded after it is thawed. Multiple freeze-thaw cycles or long-term storage at 4°C may cause breakdown of the formamide which can create ions that compete with DNA during injection. This will cause lower peak heights and decreased sensitivity.
- 4.8.7.1.2 **Caution:** Formamide is an irritant and teratogen; therefore universal precautions and a fume hood shall be utilized when manually working with formamide to avoid inhalation and contact with the skin.
- 4.8.7.1.3 Thaw the CC5 ILS 500 Y23, the allelic ladder, and an aliquot of Hi-Di™ Formamide. When thawed, centrifuge briefly then vortex to mix (do not centrifuge the CC5 ILS 500 Y23 after vortexing).

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 4.8.7.1.4 Determine the number of samples to be injected, including controls (reagent blanks, positive control and amplification blank) and allelic ladders. Add 2 to 4 reactions to this number to compensate for the loss that occurs during reagent transfers.
- 4.8.7.1.5 Prepare a loading cocktail by combining the internal lane standard (CC5 ILS 500 Y23) with the Hi-Di™ Formamide as follows:
- 4.8.7.1.6 $[(1 \mu\text{l CC5 ILS 500 Y23}) \times (\# \text{ samples})] + [(9 \mu\text{l Hi-Di}^{\text{TM}} \text{ Formamide}) \times (\# \text{ samples})]$ (recommended).
- 4.8.7.1.7 The volume of CC5 ILS 500 Y23 used in the loading cocktail may be decreased to optimize size standard peaks. The optimal range of peak heights for the size standard will vary based on the injection protocol. Targeting peak heights between ~500 RFU and ~4000 RFU should be sufficient to minimize pull-up peaks into the other dyes channels. Optimization of size standard peaks to limit the observation of pull-up while maintaining sufficient peak heights can be obtained by using 0.5 to 1.0 μl of CC5 ILS 500 Y23 per well. The amount of Hi-Di™ Formamide shall be adjusted so that the total amount of loading cocktail for each well is 10 μl .
- 4.8.7.1.8 Vortex to mix.
- 4.8.7.1.9 Pipette 10 μl of the formamide/CC5 ILS 500 Y23 mixture into each well. (Add formamide or formamide/CC5 ILS 500 Y23 mixture into empty wells to complete an injection set of eight. Every well in which an injection is occurring must contain liquid.)
- 4.8.7.1.10 Add 1 μl of amplified sample or 1 μl of the allelic ladder to each well. It is recommended that one allelic ladder is injected within each set of 3 injections on the 8 capillary Applied Biosystems® 3500 instruments to ensure that a usable ladder injection occurs. At least one allelic ladder is required within each run folder.
- 4.8.7.1.11 Cover the wells with the plate septa and briefly spin down to remove air bubbles.
- 4.8.7.1.12 Denature the samples at 95°C for ~3 minutes, then immediately chill on crushed ice or a cold pack for ~3 minutes. Denature the samples just prior to loading the instrument. Avoid denaturing the samples for longer than 3 minutes as extended heat denaturing can lead to the appearance of artifacts.

4.8.7.2 Creating a Plate Record

- 4.8.7.2.1 Open the 3500 Data Collection Software. The Dashboard screen will launch. Ensure that the Consumable Information and Maintenance Notifications are acceptable. The oven temperature should be set to 60°C.
- 4.8.7.2.2 Select “Start Pre-Heat”. This should be done at least 30 minutes prior to the first injection.

Dashboard:

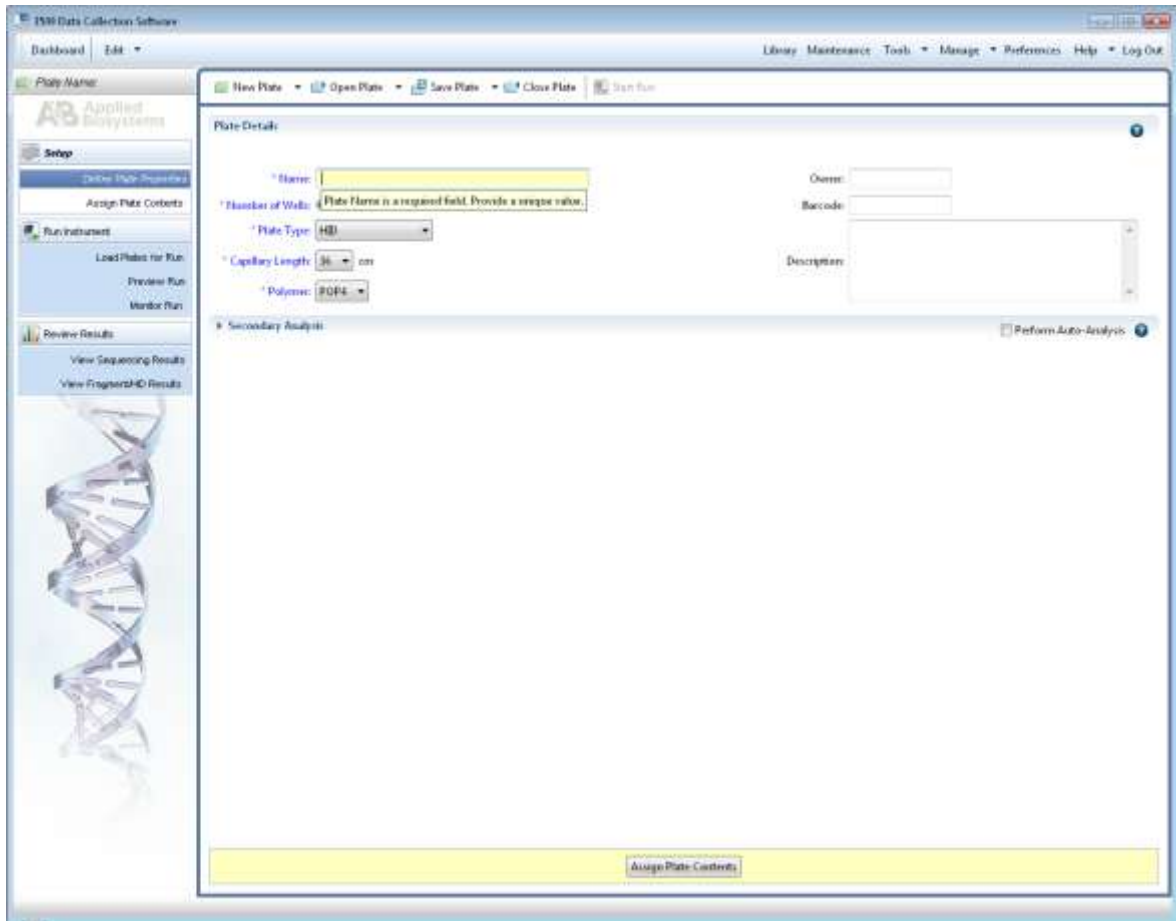
INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



- 4.8.7.2.3 Select “Create New Plate”. Alternatively, “Create Plate from Template” may be used.
- 4.8.7.2.3.1 Assign the plate name with the laboratory case number, the date and the injection number of the plate (ex. 00A1234_01Jan13_01).
- 4.8.7.2.3.1.1 If the plate is re-injected the “01” number shall increase sequentially (00A1234_01Jan13_02).
- 4.8.7.2.3.1.2 If the plate is re-injected on a different day, the original date should still be used from when the plate was prepared.
- 4.8.7.2.3.1.3 If a second preparation of a plate is made on the same date as the first, it shall be designated with a “-2” after the date (00A1234_01Jan13-2_01).
- 4.8.7.2.4 Select “96” for Number of Wells.
- 4.8.7.2.5 Select “HID” for Plate Type.
- 4.8.7.2.6 Select “36” for Capillary Length.
- 4.8.7.2.7 Select “POP4” for Polymer.

Create A Plate:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



4.8.7.2.8 Click on “Assign Plate Contents”.

4.8.7.2.9 Enter sample information or import a plate record.

4.8.7.2.9.1 The sample name shall include the sample sub-item as well as the laboratory case number (ex. 1A1_00A1234) if more than one case is included on the plate. If only one case is present on the plate then only the subitem number is required.

4.8.7.2.9.2 In order to aid in GeneMapper® ID-X sample analysis, it is recommended to place a “z” in front of the sample name for known standards (ex. z1A1_00A1234”) here or in Genemapper ID-X under sample name.

4.8.7.2.10 Under “Assays” click “Add from Library” and select the appropriate assay. Click “Add to Plate” then “Close”.

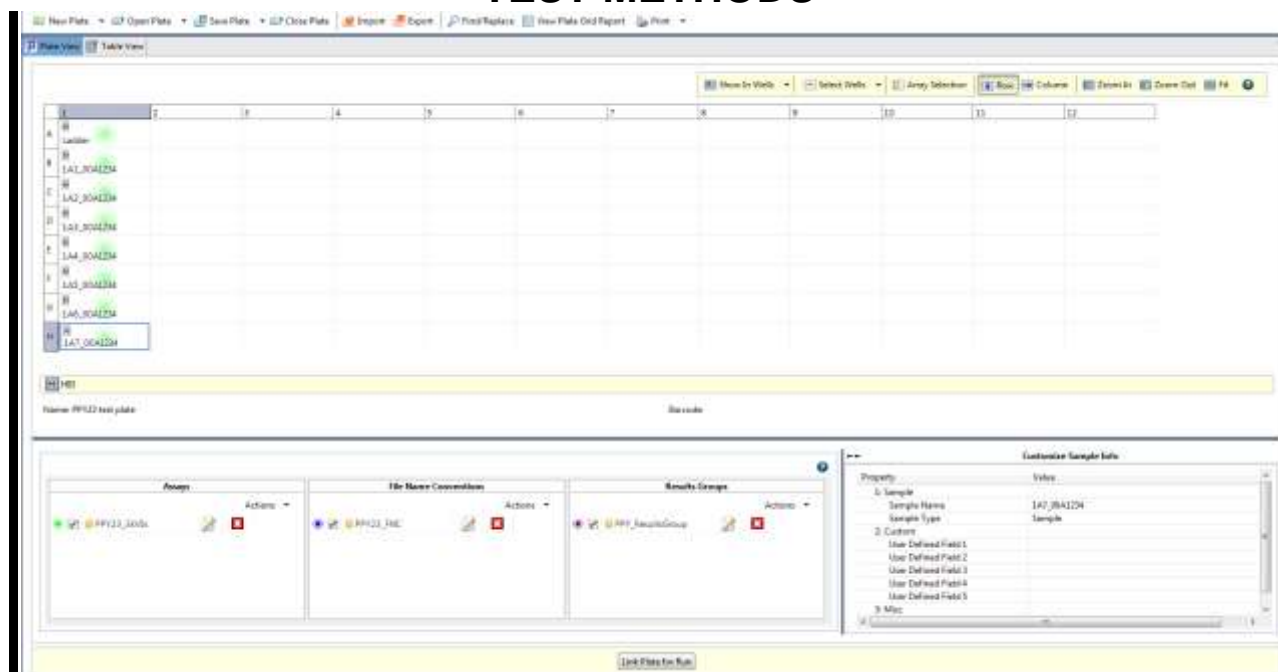
4.8.7.2.11 To add an additional assay to the plate, click the “Actions” arrow, select “Add from Library” and select the appropriate assay.

4.8.7.2.12 Under “File Name Convention”, click “Add from Library” and select “PPY23_FNC”. Click “Add to Plate” then “Close”.

4.8.7.2.13 Under “Results Groups”, click “Add from Library” and select “PPY_ResultsGroup”. Click “Add to Plate” then “Close”.

Assign Plate Contents:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



4.8.7.2.14 On the bottom-right side of the screen expand the “Customize Sample Info” window so it appears as shown above.

4.8.7.2.14.1 Use the drop-down box to select a sample type for each sample (ex. Ladder, Sample, Positive Control and Negative Control). For imported plates, this will be done automatically.

4.8.7.2.14.2 Minimize the “Customize Sample Info” window.

4.8.7.2.15 Highlight the sample wells and then select the boxes in the Assays, File Name Conventions and Results Groups that pertain to those samples.

4.8.7.2.16 Place plate on instrument in position A. Select “Link Plate for Run”. Click “OK”. The instrument automatically senses the plate and puts the information in the Plate A field. Click “OK”.

4.8.7.2.17 To add a second plate, follow steps 4.8.7.2.3 through 4.8.7.2.15. Place the plate in position B. Select the “Link Plate for Run” and click “OK”. The instrument automatically senses the plate and put the information in the Plate B field. Click “OK”.

4.8.7.3 Start a Plate Run

4.8.7.3.1 A unique run name is automatically generated by the instrument for each plate.

4.8.7.3.2 If you want to perform the injections in a certain order, click “Create Injection List” and use the arrows to re-order the injections.

4.8.7.3.3 Click “Start Run”.

4.8.7.3.4 After the run is complete, click “Unlink Plate” and remove it from the instrument.

4.8.7.3.5 Fill out a Plate Record Worksheet for each plate. Copies of the plate record worksheet shall be maintained in the case record.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

4.8.8 See DNA Test Methods Section 2.8.15 for GeneMapper® *ID-X* Version 1.4 Software User Accounts and Security Setting Procedures.

4.8.9 GeneMapper® *ID-X* Version 1.4 Software - PowerPlex® Y23 Software Settings

4.8.9.1 Importing Panel and Bin Files

- 4.8.9.1.1 Open the GeneMapper® *ID-X* Version 1.4 software.
- 4.8.9.1.2 Select “Tools” then “Panel Manager”.
- 4.8.9.1.3 Highlight the “Panel Manager” icon in the navigation pane.
- 4.8.9.1.4 Select “File” then “Import Panels”.
- 4.8.9.1.5 Navigate to the saved panel, bin, and stutter files. Select “PowerPlexY23_Panels_IDX_v1.2” then click “Import”.
- 4.8.9.1.6 Select the “ISP Casework Security Group”. Click “OK”.
- 4.8.9.1.7 In the navigation pane, highlight the “PowerPlexY23_Panels_IDX_v1.2” folder.
- 4.8.9.1.8 Select “File”, then “Import Bin Set”.
- 4.8.9.1.9 Select “PowerPlexY23_Bins_IDX_v1.2” then click “Import”.
- 4.8.9.1.10 In the navigation pane, highlight the “PowerPlexY23_Panels_IDX_v1.2” folder.
- 4.8.9.1.11 Select “File”, then “Import Marker Stutter”. A warning box will appear asking to overwrite the current values. Select “Yes”.
- 4.8.9.1.12 Select “PowerPlexY23_IDX_v1.2” then click “Import”. This will import the Promega Marker Stutter file that has been modified to include the Indiana State Police PowerPlex® Y23 stutter percentages for filtering out stutter as determined by the internal validation studies.
- 4.8.9.1.13 In the Panel Manager window, select “Apply”, then “OK”.

4.8.9.2 Creating a Casework Analysis Method

- 4.8.9.2.1 Select “Tools”, then “GeneMapper® *ID-X* Manager”.
- 4.8.9.2.2 Select the Analysis Methods tab.
- 4.8.9.2.3 Select “New” and a new analysis method dialog box will open.
- 4.8.9.2.4 Enter the name “PowerPlex Y23”.
- 4.8.9.2.5 Select the “ISP Casework Security Group”.
- 4.8.9.2.6 Enter 3500 as the instrument.
- 4.8.9.2.7 Select the “Allele” tab. In the “Bin Set” drop-down menu select “PowerPlexY23_Bins_IDX_v1.2”. Ensure that the “Use marker-specific stutter ratio if available” box is checked. Enter the values shown in Figure 1 for proper filtering of stutter peaks.

Figure 1: The Allele Tab

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Analysis Method Editor

General **Allele** Peak Detector Peak Quality SQ & GQ Settings

Bin Set: PowerPlexY23_Bins_IDX_v1.2

☒ Use marker-specific stutter ratio and distance if available

Marker Repeat Type:		Tri	Tetra	Penta	Hexa
Global Cut-off Value		0.0	0.0	0.0	0.0
MinusA Ratio		0.0	0.0	0.0	0.0
MinusA Distance	From	0.0	0.0	0.0	0.0
	To	0.0	0.0	0.0	0.0
Global Minus Stutter Ratio		0.0	0.0	0.0	0.0
Global Minus Stutter Distance	From	2.25	3.25	4.25	5.25
	To	3.75	4.75	5.75	6.75
Global Plus Stutter Ratio		0.0	0.0	0.0	0.0
Global Plus Stutter Distance	From	0.0	0.0	0.0	0.0
	To	0.0	0.0	0.0	0.0

Amelogenin Cutoff 0.0

Range Filter... Factory Defaults

Save As Save Cancel Help

4.8.9.2.8 Select the “Peak Detector” tab. Change the settings to match Figure 2.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Figure 2: The Peak Detector Tab.

Analysis Method Editor

General | Allele | **Peak Detector** | Peak Quality | SQ & GQ Settings

Peak Detection Algorithm: Advanced

Ranges

Analysis: Full Range (dropdown)
Start Pt: 0
Stop Pt: 10000

Sizing: Partial Sizes (dropdown)
Start Size: 60
Stop Size: 500

Smoothing and Baseline

Smoothing: ☐ None ☒ Light ☐ Heavy

Baseline Window: 51 pts

Size Calling Method

☐ 2nd Order Least Squares
☐ 3rd Order Least Squares
☐ Cubic Spline Interpolation
☒ Local Southern Method
☐ Global Southern Method

Peak Detection

Peak Amplitude Thresholds:

B: 75 R: 75
G: 75 P: 50
Y: 75 O: 75

Min. Peak Half Width: 2 pts
Polynomial Degree: 3
Peak Window Size: 15 pts

Slope Threshold

Peak Start: 0.0
Peak End: 0.0

Normalization

☐ Use Normalization, if applicable

Factory Defaults

Save As Save Cancel Help

- 4.8.9.2.9 The Peak Amplitude Threshold (analytical threshold) values were determined during the internal validation by calculating the noise level of each instrument and determining the cut-off in which the majority of the noise peaks would be below.
- 4.8.9.2.10 Select the "Peak Quality" tab. Change the settings to match Figure 3.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Figure 3: The Peak Quality Tab

The screenshot shows the 'Analysis Method Editor' dialog box with the 'Peak Quality' tab selected. The dialog has five tabs: 'General', 'Allele', 'Peak Detector', 'Peak Quality', and 'SQ & GQ Settings'. The 'Peak Quality' tab contains the following settings:

- Min/Max Peak Height (LPH/MPH)**
 - Homozygous min peak height: 250.0
 - Heterozygous min peak height: 75.0
 - Max Peak Height (MPH): 28000.0
- Peak Height Ratio (PHR)**
 - Min peak height ratio: 0.7
- Broad Peak (BD)**
 - Max peak width (basepairs): 1.5
- Allele Number (AN)**
 - Max expected alleles:
 - For autosomal markers & AMEL: 2
 - For Y markers: 1
- Allelic Ladder Spike**
 - Spike Detection: Enable (dropdown)
 - Cut-off Value: 0.2
- Sample Spike Detection**
 - Spike Detection: Enable (dropdown)

At the bottom right of the dialog is a 'Factory Defaults' button. At the bottom of the dialog are four buttons: 'Save As', 'Save', 'Cancel', and 'Help'.

4.8.9.2.11 Leave the "SQ and GQ Settings" tab set to the factory defaults.

4.8.9.2.12 Select "Save".

4.8.9.3 Creating a Size Standard

4.8.9.3.1 The "CC5_ILS_500_IDX" size standard will be used (see figure below for exact settings and sizes).

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Size Standard Editor

Edit

Size Standard Description

Name: CC5_ILS_500_IDX

Security Group: ISP Casework Security Group

Description:

Size Standard Dye: Orange

Size Standard Table

	Size in Basepairs
1	60.0
2	65.0
3	80.0
4	100.0
5	120.0
6	140.0
7	160.0
8	180.0
9	200.0
10	225.0
11	250.0
12	275.0
13	300.0
14	325.0
15	350.0
16	375.0
17	400.0
18	425.0
19	450.0
20	475.0
21	500.0

Insert Delete

OK Cancel Help

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

4.8.9.4 Creating a Table Setting

- 4.8.9.4.1 Select “Tools”, then “GeneMapper Manager”.
- 4.8.9.4.2 Select the “Table Setting” tab and click “New”.
- 4.8.9.4.3 Under the “General” tab, name the Table Setting “PPY23” and select the “ISP Casework Security Group”.
- 4.8.9.4.4 Under the “Samples” tab, ensure that check marks are located next to only the following: Status, Sample File, Sample Name, Sample Type, Analysis Method, Panel, Size Standard, Sizing Quality Overridden, Sample File Not Found, Sample Off-scale, and Sizing Quality. Leave the font “Arial” and the size 11. Sort by “Sample Type” and then by “Sample Name.” Select the “Ascending” option for both, and leave the final sort option to “None”.
- 4.8.9.4.5 Under the “Genotypes” tab, ensure that check marks are located next to only the following: Sample Name, Marker, Allele, and Height. Sort by “Sample Name,” then by “Marker,” and then by “None.” Select the “Ascending” option for all three. Change the “Show number of alleles” to 8 and check “Keep Allele, Size, Height, Area, Data Point, Mutation and Comment together”. (If the option to “Keep Allele, Size, Height...” is not visible in the window, expand the window size until the option appears.) Leave the font “Arial” and the size 11.
- 4.8.9.4.6 Select “OK”.

4.8.9.5 Creating a Plot Setting – Samples, Controls, and Ladders

- 4.8.9.5.1 Select “Tools”, then GeneMapper Manager”.
- 4.8.9.5.2 Select the “Plot Settings” tab and click “New”.
- 4.8.9.5.3 Under the “General” tab, name the Plot Setting “PPY23” and select the “ISP Casework Security Group”.
- 4.8.9.5.4 Under the “Sample Header” tab, ensure that check marks are located next to the following: Sample File, Sample Name, Panel, Sizing Qualify Overridden, Sample Off-scale, and Sizing Quality.
- 4.8.9.5.5 Under the “Genotype Header” tab, ensure that check marks are located next to the following: Sample File, Sample Name, Panel, Marker, Off-scale, Out of Bin Allele, Peak Height Ratio, Control Concordance, and Genotype Quality.
- 4.8.9.5.6 Under the “Sizing Table” tab, ensure that check marks are located next to the following: Dye/Sample Peak, Sample File Name, Marker, Allele, Size, Height, Area, and Data Point. Leave the font “Arial” and the size 11.
- 4.8.9.5.7 Select the “Labels” tab. Change the settings to match the following figure. Alternative, if the allele edit comment” function is not being used, “Label 4” for “Assigned Allele”, “Custom Allele”, and “Artifact” can be changed to “NONE”.

Labels Tab:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

The screenshot shows the 'Plot Settings Editor' dialog box with the 'Labels' tab selected. The dialog has a red title bar and a close button (X) in the top right corner. The 'Labels' tab is highlighted in the top navigation bar, which also includes 'General', 'Sample Header', 'Genotype Header', 'Sizing Table', and 'Display Settings'. The main content area is titled 'Show Labels on Samples and Genotypes Plot:'. Below this, there is a section labeled 'Labels' containing a table of settings for four labels (Label 1 to Label 4) across four categories: Assigned Allele, Custom Allele, Allelic Ladder, and Artifact. The settings are as follows:

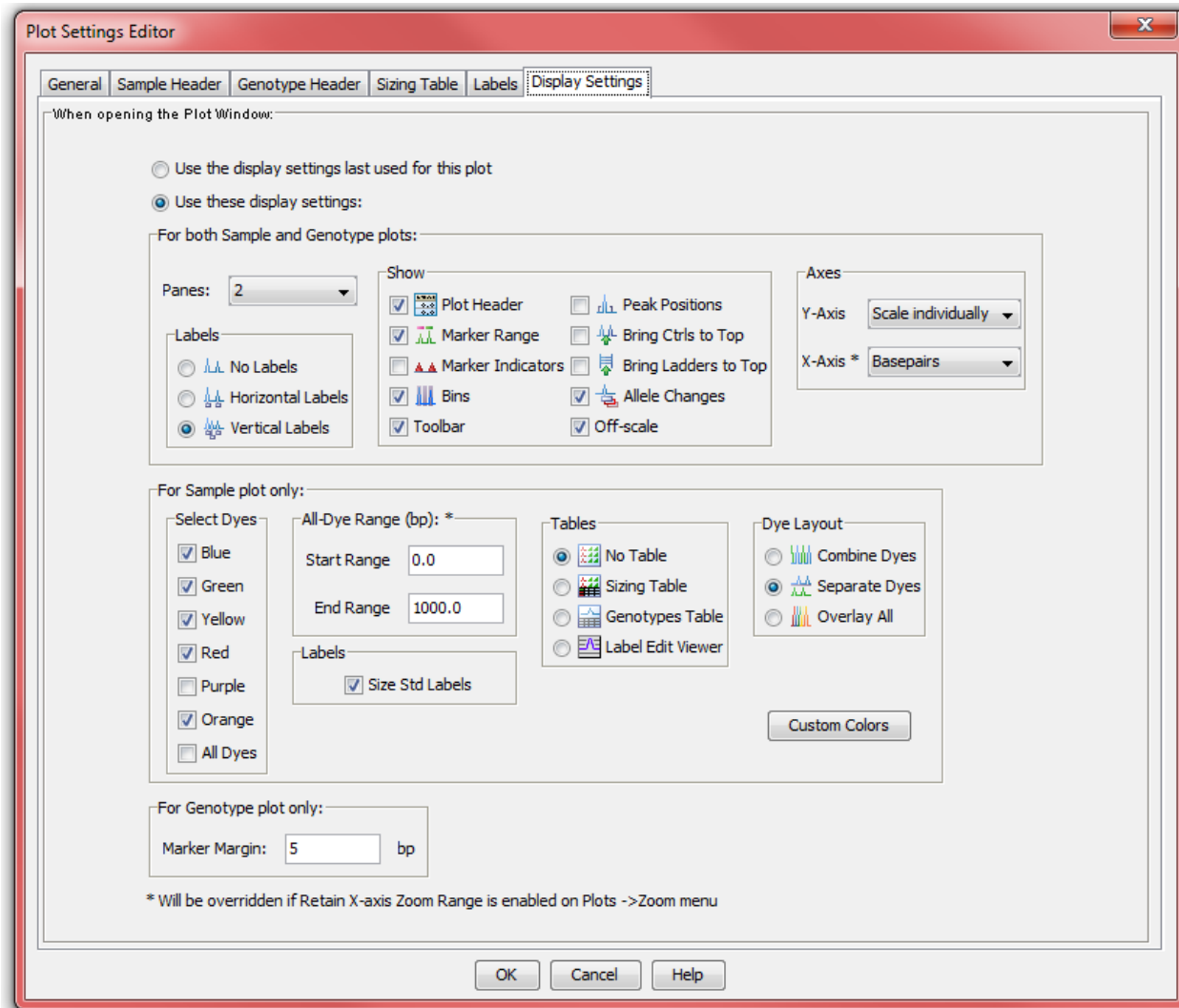
	Assigned Allele	Custom Allele	Allelic Ladder	Artifact
Label 1:	Allele Call	Allele Call	Allele Call	Artifact Label
Label 2:	Height	Height	NONE	Height
Label 3:	Size	Size	NONE	Size
Label 4:	NONE	NONE	NONE	NONE

Below the table, there is a 'Font' section with a 'Font:' dropdown set to 'Times New Roman' and a 'Size:' dropdown set to '9'. At the bottom of the dialog, there is a 'When opening the Plot Window:' section with four checkboxes: 'Show PQV trigger peak (LPH,MPH,BD,OS)' (unchecked), 'Show data type prefixes' (unchecked), 'Display virtual allele label in black' (checked), and 'Show type of edit' (unchecked). Below these checkboxes is a 'Label Color:' dropdown set to 'Dye Color-Border'. At the very bottom of the dialog are three buttons: 'OK', 'Cancel', and 'Help'.

4.8.5.9.8 Under the “Display Settings” tab, change the display settings so that they match the following figure.

Display Settings Tab:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



Select "OK".

4.8.10 GeneMapper® ID-X Version 1.4 Software - PowerPlex® Y23 Data Analysis

4.8.10.1 Processing Sample Data

- 4.8.10.1.1 Import the sample files from a single run folder by "Edit", then selecting "Add Samples to Project".
- 4.8.10.1.2 In the "Add Samples to Project" screen, navigate to the run folder that contains the sample files. If the entire run folder is to be imported, click on the folder to highlight it; then click the "Add to List" button at the bottom of the window. If the run folder was shared between multiple cases, expand the folder to view the samples. Highlight the appropriate samples, ensuring that the allelic ladder and all the desired samples are selected. Once all the samples are selected click the "Add to List" button at the bottom of the window.
- 4.8.10.1.3 Only one injection parameter per project. A run folder **shall not** be created manually by manipulating sample files.
- 4.8.10.1.4 Ensure that the necessary files are now located in the "Samples to Add" window by double-clicking on the folder in the right pane, then click "Add".

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 4.8.10.1.5 After the samples have been added to the project, first briefly scan the raw data to ensure that a bad injection did not occur. To check the raw data, first expand the project folder in the left navigation pane, then click on a sample file, then click on the “Raw Data” tab in the right GeneMapper® window. To return to the “Samples” window, click on the project folder at the top of the left navigation pane.
- 4.8.10.1.6 The GeneMapper® *ID-X* project shall contain at least one allelic ladder from each run folder included in the project for proper genotyping. Multiple allelic ladders within a run folder will be averaged by the software to calculate the allelic bins. If a ladder injection is of low quality, delete the ladder or change the sample type from “Allelic Ladder” to “Sample” to remove it from consideration in calculating the bins.
- 4.8.10.1.7 Ensure that the table setting at the top of the screen is set to “PPY23”.
- 4.8.10.1.8 In the “Sample Type” column, use the drop-down menu to select “Allelic Ladder”, “Sample”, “Positive Control” or “Negative Control” for each sample.
- 4.8.10.1.9 In the “Analysis Method” column, for each sample select “PowerPlex Y23” from the drop-down menu. Click the column header cell to highlight the entire column, then select “Edit”, then “Fill Down” (or the shortcut Ctrl + D).
- 4.8.10.1.10 In the “Panel” column, for each sample select “PowerPlexY23_Panels_IDX_v1.2” then choose “PowerPlexY23_IDX_v1.2” from the drop-down menu. Click the column header cell to highlight the entire column, then select “Edit”, then “Fill Down” (or the shortcut Ctrl + D).
- 4.8.10.1.11 In the “Size Standard” column, select “CC5_ILS_500_IDX” from the drop-down menu. Click the column header cell to highlight the entire column, then select “Edit”, then “Fill Down” (or the shortcut Ctrl + D).
- 4.8.10.1.12 The Analysis Method, Size Standard, and Panel can be set as defaults when a GeneMapper® *ID-X* project is opened. Under the “File” menu, select “Project Options”. Under the “Add Samples” tab select the above settings as the default in the drop-down menus for Analysis Method, Size Standard and Panel. Click “OK”.
- 4.8.10.1.13 Select the green “Analyze” arrow button to start the data analysis. At the Project name prompt, save the project. At a minimum the project name shall contain the injection parameters for the project and date the sample run was started on the instrument. The case number is recommended but not required. Select the “ISP Casework Security Group”.

4.8.10.2 Evaluating Sample Data

- 4.8.10.2.1 The Sizing Quality shall be at least 0.49 for it to pass and should be close to 1.0.
- 4.8.10.2.2 Highlight all sample rows containing Allelic Ladders. Then click “View”, then “Display Plots”. In the Samples Plot screen, change the “Plot Setting” drop-down box to “PPY23”. Magnify the area from approximately 75 bp to 500 bp. Then click “File”>“Print”>“Print” to print off the allelic ladder electropherograms. Check the allelic ladders to ensure that the correct

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

allele calls are made for each peak. (Refer to the PowerPlex®Y23 System Technical Manual for current Allelic Ladder allele calls.) Close out of the Samples Plot window.

- 4.8.10.2.3 Highlight all sample rows containing negative controls (ex. amplification blanks and reagent blanks). Then click “View”, then “Display Plots”. In the Samples Plot screen, change the “Plot Setting” drop-down box to “PPY23”. Print off the entire electropherogram ensuring that the primer peak is visible by clicking “File”>“Print”>“Print” to print off the negative control electropherograms. Check the negative controls to ensure that no peaks above threshold are present. Close out of the Samples Plot window.
- 4.8.10.2.4 Highlight all remaining sample rows. Then click “View”, then “Display Plots”. In the Samples Plot screen, change the “Plot Setting” drop-down box to “PPY23”. Magnify the area from approximately 75 bp to 500 bp. After evaluating all allele calls, click “File”>“Print”>“Print” to print off all sample electropherograms. Optionally, the remaining sample rows may be viewed, evaluated, and printed with the Allelic Ladders.
- 4.8.10.2.5 After all analysis is complete, save the 3500 Data Collection Run Folder and associated GeneMapper® *ID-X* projects under each associated laboratory case number and request folder located in the analysts’ folders on the server. Projects should be deleted monthly from the “GeneMapper® *ID-X* Manager” to maintain database space.
 - 4.8.10.2.5.1 When exporting the GeneMapper® *ID-X* project, ensure that the “Export with analysis settings” box is checked.
- 4.8.10.2.6 The number of audit records on the GeneMapper® *ID-X* database should be routinely checked. Audit records should be backed-up, saved to the DNA server, and then deleted from the GeneMapper® *ID-X* database monthly or if the number of records exceeds 40,000. If the number of audit records exceeds 60,000, the performance of the software may be affected.
- 4.8.10.2.7 The amount of database space in the GeneMapper® *ID-X* software should be routinely checked. If the occupied space exceeds 80%, additional disk space should be allocated.

4.8.11 Interpretation Guidelines For PowerPlex® Y23

- 4.8.11.2 Once a determination has been made whether a peak is to be considered a true allele, the following interpretation guidelines shall be used. The minimum peak height threshold is established at 75 relative fluorescent units (RFU) for GeneMapper® *ID-X* software. The analytical threshold for data interpretation is 75 RFU. The stochastic threshold for data interpretation of the DYS385 a/b locus is 250 RFU.
- 4.8.11.3 Peaks below 75 RFU shall not be interpreted or marked on the STR summary sheet.
- 4.8.11.4 Interpretation of peaks with RFU from 75 to 250 RFU at the DYS385 a/b locus is a qualitative assessment. It shall be interpreted with care. If the DYS385 a/b locus demonstrates a single allele that is above 75 RFU and below 250 RFU, true homozygosity cannot be determined due to possible stochastic effects and it will be reported with a bracket (ex. [13]) on the Y-STR summary sheet. If the DYS385 a/b locus demonstrates two alleles in which one or both alleles are above 75 RFU and below 250 RFU, and the sample appears to be single source, the allele(s) below 250

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

RFU will be reported with a bracket. Both alleles are interpretable and may be used in a Y-STR database search.

4.8.11.5 Peaks at the remaining loci with RFU of 75 and above are reportable based on both qualitative and quantitative assessment of data.

4.8.11.6 **Controls:**

4.8.11.6.2 The appearance of pull-up or known artifact peaks does not render the following controls inconclusive.

4.8.11.6.3 **Reagent Blank:** The purpose of the reagent blank is to determine if the reagents used to extract the associated samples were contaminated by male DNA. Therefore no signal should be detected in this sample well other than the internal lane standard.

4.8.11.6.3.1 A reagent blank with peaks below 75 RFU shall not prevent associated samples from being interpreted, but the Technical Leader and Supervisor shall be notified (with documentation in the case record) if more than two loci demonstrate peaks.

4.8.11.6.3.2 A reagent blank with peaks of 75 RFU and above shall be considered a failed negative control. All associated samples shall be inconclusive. All the samples shall be repeated when reasonable and appropriate.

4.8.11.6.4 **Positive Control:**

4.8.11.6.4.1 The 2800M or other appropriate male DNA standard supplied with the PowerPlex® Y23 kit is used as a positive control to demonstrate that the kit is performing properly. If the expected alleles are not detected in the positive control well, then the test is considered inconclusive.

Y-STR Locus	2800M
DYS576	18
DYS389 I	14
DYS448	19
DYS389 II	31
DYS19	14
DYS391	10
DYS481	22
DYS549	13
DYS533	12
DYS438	9
DYS437	14
DYS570	17
DYS635	21
DYS390	24
DYS439	12
DYS392	13
DYS643	10
DYS393	13

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

DYS485	17
DYS385 a/b	13,16
DYS456	17
Y-GATA-H4	11

4.8.11.6.5 Amplification blank:

- 4.8.11.6.5.1 The purpose of the amplification blank is to determine if male DNA contaminated the samples at the amplification step. Because no template DNA was placed in the reaction tube, the sample well should be blank except for the internal lane standard peaks. If amplified product is detected in the amplification blank well, the test is considered inconclusive.
- 4.8.11.6.5.2 An amplification blank with peaks below 75 RFU shall not prevent associated samples from being interpreted, but the Technical Leader and Supervisor shall be notified (with documentation in the case record if more than two loci demonstrate peaks).
- 4.8.11.6.5.3 An amplification blank with peaks of 75 RFU and above shall be considered failed negative controls. All associated samples shall be inconclusive. All the samples shall be repeated when reasonable and appropriate.
- 4.8.11.7 The analytical threshold shall be determined during validation. If an analyst has determined that a peak that has been labeled by the GeneMapper® *ID-X* software is not a true allele peak, the analyst can delete the allele call label in either the software file or manually on the printed electropherograms. The GeneMapper® *ID-X* software is set to display all allele changes. Therefore, any change or deletion in an allele call shall be visible on the electropherogram print-out.
- 4.8.11.8 An analyst is required to visually confirm all allelic ladders used for allele designation and the allele calls for all positive controls.
- 4.8.11.9 **Stutter peaks** are artifacts of the amplification process. These peaks will typically be observed in the n-4 position of major peaks for tetranucleotide repeat loci, in the n-5 position of major peaks for the pentanucleotide repeat locus, in the n-6 position of major peaks for the hexanucleotide repeat locus, or in the n-3 position of the major peaks for the trinucleotide repeat loci. The peak heights of stutter peaks will be less intense than that of the major peak. The average observed percent stutter for each locus and the mean + 3 SD values are listed in the table in Appendix 9. The mean stutter value for each locus is used as the stutter cut-off value in the marker stutter file "PowerPlexY23_IDX_v1.2" for GeneMapper® *ID-X* analysis. Therefore, any peaks in the n-4 (for tetranucleotide repeats), the n-3 (for trinucleotide repeats), the n-5 (for pentanucleotide repeats), or the n-6 (for hexanucleotide repeats); and n-2/n+2 associated with the DYS19 locus stutter positions that are below these values when compared to the major peak will be automatically filtered out by the software and will not be labeled. However, these values may vary slightly. There are also stutter-like peaks at the n-9 and n-2 positions and are also listed on the table below. This column may be used as a guideline to the analyst for determining stutter peaks that were not filtered out by the software. It is the analyst's discretion to determine which allele calls may be renamed as stutter in GeneMapper® *ID-X* analysis. For samples which have been over-loaded, the percent stutter calculation will not be accurate due to the saturation effect of the major peak. In addition to stutter peaks,

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

several other stutter-like peaks can be observed at some PowerPlex® Y23 loci, especially when samples are amplified at high concentrations.

- 4.8.11.9.2 **Note:** Stutter peaks have also been observed during the validation process at the n+4 (tetranucleotide) and n+3 (trinucleotide) positions as well as the n-8 (tetranucleotide) and n-6 (trinucleotide) positions. These values are listed in the table below. Other artifacts of less intensity have been reported which may not line up with the ladder. The interpretation of these peaks, similar to the other artifact peaks, shall be at the discretion of the analyst based on their training and experience.

Stutter Table: See [Appendix 9](#)

- 4.8.11.10 **Artifacts** have been observed utilizing the PowerPlex® Y23 amplification kit. The intensity of these peaks is directly related to signal intensity; therefore, reducing the signal intensity to less than 15,000 RFU should minimize the appearance of these types of artifacts. If an analyst renames the allele call of any artifact in GeneMapper® ID-X, it shall be labeled appropriately. Artifact peaks have been documented at 66-69 base pairs in the Fluorescein dye channel and at 58-60 base pairs in the JOE dye channel. The following artifacts have been observed: DYS448 in the n-9 to n-15 position; DYS635 at 160 bases; DYS481 at 164 bases; DYS549 at 187 bases; DYS458 at 201 bases; DYS533 at 253 bases and at 272 bases; and DYS643 at 427 bases and 440 bases..
- 4.8.11.11 **Pull-up or bleed through** peaks can occur if signal intensity of sample or ILS peaks is too high or if a new spectral calibration needs to be run. Any pull-up peaks called as alleles by the GeneMapper® ID-X software should be labeled on the electropherogram as pull-up. The sample should be re-run if a pull-up peak interferes with the analyst's ability to evaluate the profile based on their experience and training.
- 4.8.11.12 **Spikes** are peaks that generally appear in all colors and are sharper than regular peaks; however, they can occur predominantly in one color. Spikes are a natural consequence of capillary electrophoresis and can be caused by dust present in the system as well as urea crystals in the system. It is essential that the instrumentation be maintained and cleaned regularly to minimize the appearance of spikes. All spikes called as alleles by the GeneMapper® ID-X software should be clearly labeled as spikes on the electropherogram printout. A sample should be re-injected when a spike interferes with the analyst's ability to evaluate the profile based on their experience and training.
- 4.8.11.13 **Rare variants** have been described in the literature. The causes of these rare variants are microvariants or chromosomal mutations (duplication or deletion).
- 4.8.11.13.2 **Microvariants:** alleles one, two or three nucleotides shorter than the common four base repeat alleles (one or two nucleotides shorter in the case of three base repeat alleles or four nucleotides shorter in the case of five base repeat alleles) which are located between two alleles on the ladder shall be described as the short repeat followed by the number of base pairs it is larger (a 0.1, 0.2, 0.3, or 0.4 in the case of a pentanucleotide repeat). Therefore, if a peak is 1 base pair larger than the

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

5 allele it shall be designated as 5.1. The precision of sizing at a 99.7% confidence level is less than 0.25 bp which is precise enough to be confident in the sizing of microvariants. A microvariant 4 base pairs larger than an allele (or 5 base pairs for a pentanucleotide) on the ladder may be designated with the full repeat number (A peak 4 base pairs larger than the 5 allele could be designated a 6; 5 base pairs larger a 6.1). A current list of microvariants is available on the "Variant Allele Report" published at the U.S. National Institute of Standards and Technology (NIST) website: <http://www.cstl.nist.gov/div831/strbase> and on the Y Chromosome Haplotype Reference Database at <http://www.yhrd.org>

- 4.8.11.13.3 Alleles which are located outside the range of the ladder or bin set (above or below) shall be described as "<" or ">" the largest or smallest allele for that locus with a set of () placed around the off ladder allele. For example, if a band is located above the largest allele for the DYS19 locus, it would be designated as "(>19)". This should be clear when used and can be verified with a locus review of the electropherogram.
- 4.8.11.13.4 A duplication occurs when multiple alleles are present at a locus/loci. Duplications have been documented with the PowerPlex® Y23 amplification kit. Instances of multiple duplications within a sample have been documented as well. Most duplications have a one repeat difference; however two, three, and four repeat unit differences has been observed.
 - 4.8.11.13.4.1 Steps to distinguish between a mixture and a duplication: determine the number of loci containing more than one peak; consider the position on the Y-chromosome if multiple loci have two peaks; determine if the repeat spread is >1 repeat unit; examine DYS385 a/b for the presence of >2 peaks; and consider autosomal testing to confirm single-source sample.
- 4.8.11.13.5 A deletion occurs when there is a lack of a peak at a single locus/loci. A deletion has been reported at the DYS448 locus. Samples with this deletion will show two peaks (duplication) in DYS576 and a null allele in DYS448.
- 4.8.11.14 **Mixed DNA Samples.** All loci shall be taken into consideration when interpreting a mixture. A two-peak pattern at two or more loci (except for DYS385 a/b; this locus may exhibit three or more peaks) may be an indication of a mixture. However, two-peak patterns have been reported for single-source samples, but these instances are extremely rare. If a two-peak pattern is observed for a single-source questioned sample and is believed to be a rare variant or duplication, the profile should be re-amplified and re-analyzed to confirm the profile.
- 4.8.11.15 The "phenotype" of each profile shall be recorded.
- 4.8.11.16 All interpretation decisions shall be documented prior to comparison of known profiles. If an interpretation error is discovered after comparison to a known profile, the Technical Leader shall be consulted to determine the appropriate action. The error and Technical Leader consultation shall be documented in the case record.
- 4.8.11.17 During interpretation, the analyst and technical reviewer shall each compare all single source and major Y-STR profiles to available staff profiles to ensure that samples have not been contaminated. All instances of profiles consistent with a staff member shall be reported to the Technical Leader.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

4.8.11.18 There are four possible outcomes of Y-STR analysis:

- 4.8.11.18.2 No results: No peaks were detected on the electropherogram.
- 4.8.11.18.3 Inconclusive: Peaks were observed at one or more loci; however no conclusive results can be drawn from them.
- 4.8.11.18.4 Inclusion: The profile obtained from the questioned sample had no discrepant alleles as compared to the profile of the known standard. Allelic drop-out may occur in low concentrations or mixtures. At least twelve loci eligible for statistical calculations shall be needed to draw this conclusion.
- 4.8.11.18.5 Exclusion: The profile obtained from the questioned sample was not the same as the known material.

4.8.12 **General Rules For PowerPlex® Y23 Analysis On The Applied Biosystems® 3500 Genetic Analyzer**

- 4.8.12.2 It is required that at least one allelic ladder is present within a run folder. However, it is recommended that an allelic ladder is run within each set of 3 injections on the 8 capillary 3500 (one ladder per 24 capillaries). External environmental factors during a plate run can cause a shift in the migration of DNA fragments within the capillary which may cause a small difference in the base pair length determined for an allele. If an allelic ladder sample was not run within a reasonable time as the sample, this may cause an allele to be called off ladder.
- 4.8.12.3 If a sample is to be re-injected at higher injection parameters, the reagent blank and the amplification blank associated with that sample shall also be re-injected at the higher parameters. The positive control need not be injected at the same parameters as the samples associated with it.
- 4.8.12.4 Only the injection(s) used for interpretation need to be printed for the case record. However, other injection runs have to be noted in the case record and all data shall be saved under each associated laboratory case number and request folder located in the analysts' folders on the server. If individual samples in a case use different injection parameters, it shall be noted in the case record which injection was used for interpretation for each sample.
- 4.8.12.5 The placement of unknown samples in the 96-well plate should be done so that the orientation allows for the injection of unknown samples prior to the injection of any standards for that case.
- 4.8.12.6 Peak heights of analyzed samples should not exceed 28,000 RFU. This level of peak height is approaching saturation and will lead to the appearance of artifacts. Reducing the signal to approximately 2,000-10,000 RFU will produce optimal results. The reduction of signal can be obtained by decreasing the injection parameters. The allowable injection parameters are 3kV 8 seconds or 3 kV 3 seconds. Use of data with more than two peaks >28,000 RFU may be allowed with the approval of a Supervisor and notification to the Technical Leader documented in the case record.

4.8.13 **Archiving Applied Biosystems® 3500 and GeneMapper® ID-X Projects**

- 4.8.13.2 The 3500 run folders containing all sample files for a case as well as the GeneMapper® ID-X project file shall be saved under each associated laboratory case number and request folder located in the analysts' folders on the server and deleted from the hard drive of the instrument and/or analysis computer. The data stored on the server shall be routinely backed up to ensure security of data.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 4.8.13.3 A hard copy of all electropherograms used in interpretation as well as a print-out of the plate record shall be placed in the case record.
- 4.8.13.4 All processed plate records shall be deleted from the Data Collection Software database weekly. Run folders containing the sample files and the GeneMapper® ID-X projects shall be deleted on or after the 15th of each month on the instrument computers. It shall be each analyst's responsibility to ensure that all data is backed up prior to the 15th of the month.

4.8.14 Mixture Interpretation

- 4.8.14.2 A profile is defined as a mixture between two or more males when two or more loci demonstrate two or more alleles, except DYS385 a/b. A profile where only one locus demonstrates two alleles could be an indication of:
 - 4.8.14.2.2 A mixture where only one allele from a minor contributor is detected above analytical threshold;
 - 4.8.14.2.3 Extraneous DNA;
 - 4.8.14.2.4 A duplication.
- 4.8.14.3 In situations 1 and 2 above, report wording to the effect that one lone allele was detected and no conclusion can be reached is appropriate. In situation 3, no mention is required in the Certificate of Analysis.
- 4.8.14.4 If the profile is determined to be a mixture, each locus should be evaluated and classified as below:
 - 4.8.14.4.2 Indistinguishable mixture between two or more males; in this case, since no statistical interpretations can be made, no conclusions will be made for these samples.
 - 4.8.14.4.3 Mixture demonstrating a major contributor.
 - 4.8.14.4.4 Demonstrates the potential for allelic drop-out.
- 4.8.14.5 For mixtures of two male individuals, a profile demonstrating twelve or more loci classified as a mixture demonstrating major and minor components shall have a major single source profile calculated based on the following criteria:
 - 4.8.14.5.2 If the peak height ratio between the peaks is less than 25%, then the highest peak can be called a major at that locus.
 - 4.8.14.5.3 If there is only one peak at a particular locus (and a major can be determined at one or more loci with more than one peak), this peak can be called a major. All loci must be considered in making this determination.
 - 4.8.14.5.4 A mixture threshold of 300 RFU shall be used to interpret single peaks and major peaks at a locus. Peaks below 300 RFU shall not be used for interpretation of the mixture.
 - 4.8.14.5.5 When evaluating DYS385 a/b, a major consisting of two peaks should have a peak height ratio of 65% and the tallest of the minor peak shall have a peak height ratio of less than 25% of the shortest major peak.
 - 4.8.14.5.6 If the sample does not meet these criteria, do not call a major at this locus.
 - 4.8.14.5.7 Mixtures of three males which meet the above criteria should be interpreted with caution.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

4.8.14.5.8 Mixtures of four or more males shall be evaluated based on the following criteria. These samples should be interpreted with caution.

- 4.8.14.5.8.1 If the peak height ratio between the highest peak and tallest minor peak is less than 15%, the highest peak can be called a major at that locus.
- 4.8.14.5.8.2 A mixture threshold of 1000 RFU shall be used to interpret single peaks and major peaks at a locus.
- 4.8.14.5.8.3 When evaluating DYS385 a/b, a major consisting of two peaks should have a peak height ratio of 65% and the tallest of the minor peaks shall have a peak height ratio of less than 15% of the shortest major peak.

4.8.15 Y-STR Database Searching

- 4.8.15.2 A Y-STR profile is treated as a single locus because it is a haplotype.
- 4.8.15.3 Once a comparison between a reference sample(s) and a questioned sample is completed and an inclusion for a single source or major Y-STR profile is reported, the significance of that inclusion shall be estimated. It shall be reported that all paternally related males will share the same Y-STR profile.
- 4.8.15.4 The questioned haplotype developed for the evidence profile shall be searched against the U.S. Y-STR Database, found online at www.usystrdatabase.org.
- 4.8.15.5 The questioned haplotype shall be searched using loci from the PowerPlex® Y kit (DYS391, DYS389 I, DYS439, DYS389 II, DYS438, DYS437, DYS19, DYS392, DYS393, DYS390, and DYS385 a/b) and using loci from the PowerPlex® Y23 kit (DYS576, DYS389 I, DYS448, DYS389 II, DYS19, DYS391, DYS481, DYS549, DYS533, DYS438, DYS437, DYS570, DYS635, DYS390, DYS439, DYS392, DYS643, DYS393, DYS458, DYS385 a/b, DYS456, and Y-GATA-H4).
- 4.8.15.6 The statistic result sheet for both searches shall be printed out for every sample.
- 4.8.15.7 The number of occurrences (matching samples) found in the database from the search (counting method) shall be included in the Certificate of Analysis as a frequency estimate with the application of the 95% confidence interval. The statistic providing the most genetic information should be reported. The Certificate of Analysis shall also acknowledge that the search results given were accurate on the date of the search.

4.9 Records

- 4.9.1 The appropriate worksheets or the equivalent workbooks shall be used to record all procedures. These will be found in the Worksheet Manual.
- 4.9.2 All data sheets, notes and other information generated from the laboratory examination shall be kept in the case record.
- 4.9.3 The technical review of the case record shall be recorded on the technical review worksheet.
- 4.9.4 Electronic records shall be retained as indicated in [Appendix 7](#).

4.10 Interpretation of Results

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- 4.10.1** When test results from a questioned sample are compared with a known standard the following conclusions may be reported:
- 4.10.1.1** The questioned sample and the known standard may have common origin. If this is indicated, it shall be reported that all paternally related males will share the same profile and a frequency of occurrence in the U. S. Y-STR Database shall be calculated and reported out at a 95% confidence interval.
 - 4.10.1.2** The known standard may be excluded as a possible source of the questioned sample.
 - 4.10.1.3** No conclusion may be reached with regard to the questioned sample and the known standard.
- 4.10.2** If test results from a sample cannot be clearly interpreted, the results shall be reported as inconclusive.
- 4.10.3** See Interpretation guidelines in 4.8.14 and 4.8.17.

4.11 Reporting of Y-STR Analysis (See [1.11](#) and [2.11](#) for formatting)

See [Appendix 5](#) Y-STR reporting for specific examples

4.12 References

- 4.12.1** Promega Corporation, (2012 or most current version). Plexor® HY System for the Applied Biosystems® 7500 and 7500 FAST Real-Time PCR Systems Technical Manual. Part No. TM293. Madison, WI.
- 4.12.2** Krenke, B.E. The Plexor™ Analysis Software. Profiles in DNA. 2005. 8(2): pp.6 – 7.
- 4.12.3** Promega Corporation, (2014 or most current version). PowerPlex® Y23 System Technical Manual. Part No.TMD035. Madison, WI.
- 4.12.4** Butler, J.M. 2011. Y Chromosome DNA Testing. Advanced Topics in Forensic DNA Typing: Methodology. pp 371-403. Elsevier Academic Press. Burlington, MA.
- 4.12.5** Butler, J.M. 2010. Lineage Markers: Y Chromosome and mtDNA testing. Fundamentals of Forensic DNA Typing. pp 363-374. Academic Press. Burlington, MA.
- 4.12.6** Butler, J.M. 2005. Y Chromosome DNA Testing. Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers. Second Edition. pp 201-239. Elsevier Academic Press. Burlington, MA.
- 4.12.7** SWGDAM (2014). SWGDAM Interpretation Guidelines for Y-Chromosome STR Typing by Forensic DNA Testing Laboratories. Available at http://swgdam.org/SWGDAM_YSTR_Guidelines_APPROVED_01092014_v_02112014_FINAL.pdf
- 4.12.8** Ballantyne, J. and Fatolitis, L. The U.S. Y-STR database. Profiles in DNA. 2008. 11(1): 13 – 14.
- 4.12.9** U.S. Y-STR Database. <http://usystrdatabase.org>.

**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS**

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

5. DNA Sample Processing using the Biomek NX^P and Biomek 3000 Automated Workstations:

5.1. Scope:

- 5.1.1.** This test method is designed for the direction of laboratory personnel who will operate the Biomek NX^P and Biomek 3000 automation workstations to process DNA samples from extraction/purification through CE (capillary electrophoresis) setup. The Biomek NX^P workstation is capable of extracting up to 79 samples and blanks in two hours, setting up quantification plates, normalizing samples and setting up amplification. The Biomek 3000 workstation then transfers amplified product to a CE plate to be run on a genetic analyzer. This test method may be expanded or altered as techniques and/or new genetic analyses are found applicable and validated.

5.2. Precautions/Limitations:

- 5.2.1.** Due to the hands-off nature of automated processing, it is vital that submitted samples be prepared following procedures determined by the automation validation and that the ordered flow of data throughout the process be maintained.
- 5.2.2.** Customization or modification of sample processing procedures will not be allowed without consultation with the automation team and documented approval of the Technical Leader.

5.3. Related Information:

- 5.3.1.** N/A

5.4. Instruments:

- 5.4.1.** Biomek NX^P Automated Laboratory Workstation— robotic DNA processing system.
- 5.4.2.** Biomek 3000— robotic DNA processing system.

5.5. Reagents/Materials

- 5.5.1.** Digest/Wash Buffer
- 5.5.2.** Isopropyl Alcohol
- 5.5.3.** Nuclease Free Water (NFH₂O)
- 5.5.4.** DTT 1M
- 5.5.5.** Proteinase K (10 mg/ml)
- 5.5.6.** Proteinase K (18 mg/ml)
- 5.5.7.** Ethanol
- 5.5.8.** Sarkosyl 20% w/v
- 5.5.9.** Stain Extraction Buffer for Automation
- 5.5.10.** TRIS/EDTA/NaCl Solution
- 5.5.11.** DNA IQ Extraction Kit
- 5.5.11.1.** Lysis Buffer
- 5.5.11.2.** Elution Buffer
- 5.5.11.3.** Magnetic Resin
- 5.5.11.4.** Wash Buffer

5.6. Hazards/Safety

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 5.6.1. All chemicals shall be handled in a safe method as referenced in the specific Safety Data Sheets (SDS).
- 5.6.2. Universal Precautions shall be observed whenever biological materials are being handled.
- 5.6.3. Biological waste shall be disposed of in the appropriate waste receptacle.
- 5.6.4. On the Biomek NX^P, a light curtain prevents interaction with the deck or the robotic arm while a procedure is running.
- 5.6.5. There is an emergency stop button on the front of the Biomek 3000.

5.7. Reference Materials/Calibration Checks

- 5.7.1. DNA processing using the automated workstation does not require any additional controls to those used in manual DNA processing.
- 5.7.2. Annual calibration of the pipetting accuracy will be performed by Beckman Coulter Operational Qualification 3 (OQ3).

5.8. Procedures/Instructions

5.8.1. General Rules

- 5.8.1.1. Batch ID numbers shall be named sequentially “year-run number” (ex. 2011-001).
- 5.8.1.2. Each case shall contain at least one reagent blank for unknowns when processed on the automated workstation.
- 5.8.1.3. Each group of standards/knowns (per analyst) processed on the automated workstation shall contain at least one reagent blank. On the pre-extraction worksheet (submission form), the case number for the grouped reagent blank shall be the first case number in the batch it is associated with.
- 5.8.1.4. Reagent blanks shall contain “RB” in the name on the pre-extraction worksheet.
- 5.8.1.5. Within 24 hours of incubation, analysts shall deliver samples to be processed to the automation room. An e-mail shall be sent to the automation team at DAutomation@ISP.IN.gov with the completed pre-extraction worksheet attached. The form shall be named “date_initialsPE_submission#” (ex. 01Jan11_AB1234_01) and the tube rack containing the samples shall be labeled the same.
- 5.8.1.6. To maximize efficiency of each run, the automation team may process samples up to 14 days from their submission date.
- 5.8.1.7. When entered on the pre-extraction worksheet, case numbers and sample names shall not contain special characters except for dashes and underscores.
- 5.8.1.8. In addition to the documentation of data as described in the Forensic Biology Section Test Method (DNA Test Methods, section 2), the associated automation documents to be printed and retained in the case record are the pre-extraction worksheet, the

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

extraction/quantification plate record, the amplification/capillary electrophoresis plate record, and the amplification normalization report.

5.8.2. Sample Preparation

5.8.2.1. Preparation of Samples For Blood, Hair, Saliva, Epithelial Cell Samples And Blood Or Buccal Swab Standards

- 5.8.2.1.1. For each sample, combine 350 µl Stain Extraction Buffer for Automation (SEBA) with 10 µl Pro K (18 mg/ml) and 40 µl DTT (1M). *Example: for 16 samples, combine 5,600 µl Incubation Buffer (or SEBA) with 160 µl Pro K and 640 µl DTT.*
- 5.8.2.1.2. Place sample at the bottom in a 1.5 ml microcentrifuge tube (See sampling protocols in 2.8.3.3). Each group of samples being extracted shall include a reagent blank as the last sample in the batch.
 - 5.8.2.1.2.1. For extraction on the Biomek NX^P workstation, samples shall be loaded specifically into Eppendorf (Hamburg, Germany) Safe-Lock 1.5 ml Tubes (Cat. no. 022363212) or Promega (Madison, WI) ClickFit 1.5 ml microtubes (Cat. no. V4741). Do not use "dolphin-style" or other microcentrifuge tubes.
- 5.8.2.1.3. To the sample add 400 µl Buffer/Pro K/DTT Master Mix. Vortex and spin briefly in a microcentrifuge or tap the tube to force the cutting into the extraction fluid.
 - 5.8.2.1.3.1. Do NOT add more than 400 µl of liquid per sample.
- 5.8.2.1.4. Incubate the sample at 56°C for at least one hour. Alternatively, samples may be incubated overnight.
- 5.8.2.1.5. Spin briefly in a microcentrifuge to force the condensate into the bottom of the tube. (For hairs it may be preferable to transfer supernatant to a clean microcentrifuge tube before proceeding).
- 5.8.2.1.6. Using a wooden applicator stick, remove the cutting and proceed to 5.8.2.1.7 or:
- 5.8.2.1.7. Transfer the cutting into a spin basket insert. Place the basket insert into the tube containing the stain extract. Spin in a microcentrifuge at approximately 14,000 rcf for about 5 minutes. Remove and discard the basket insert.
- 5.8.2.1.8. Close the lid of the sample tube and cut the hinge.
- 5.8.2.1.9. Save the extract until ready for automated DNA extraction. Do not refrigerate or freeze sample. Prior to submission to the automation team, processed samples may be left at room temperature (22-25°C) overnight, if necessary.

5.8.2.2. Preparation of Samples For Differential Extraction

- 5.8.2.2.1. For each sample, combine 240 µl Tris/EDTA/NaCl, 6 µl 20% Sarkosyl, 54 µl NFH₂O and 3 µl Proteinase K (10 mg/ml). *Example: for 16 samples, combine 3840 µl Tris/EDTA/NaCl, 96 µl 20% Sarkosyl, 864 µl NFH₂O, and 48 µl Pro K.*

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

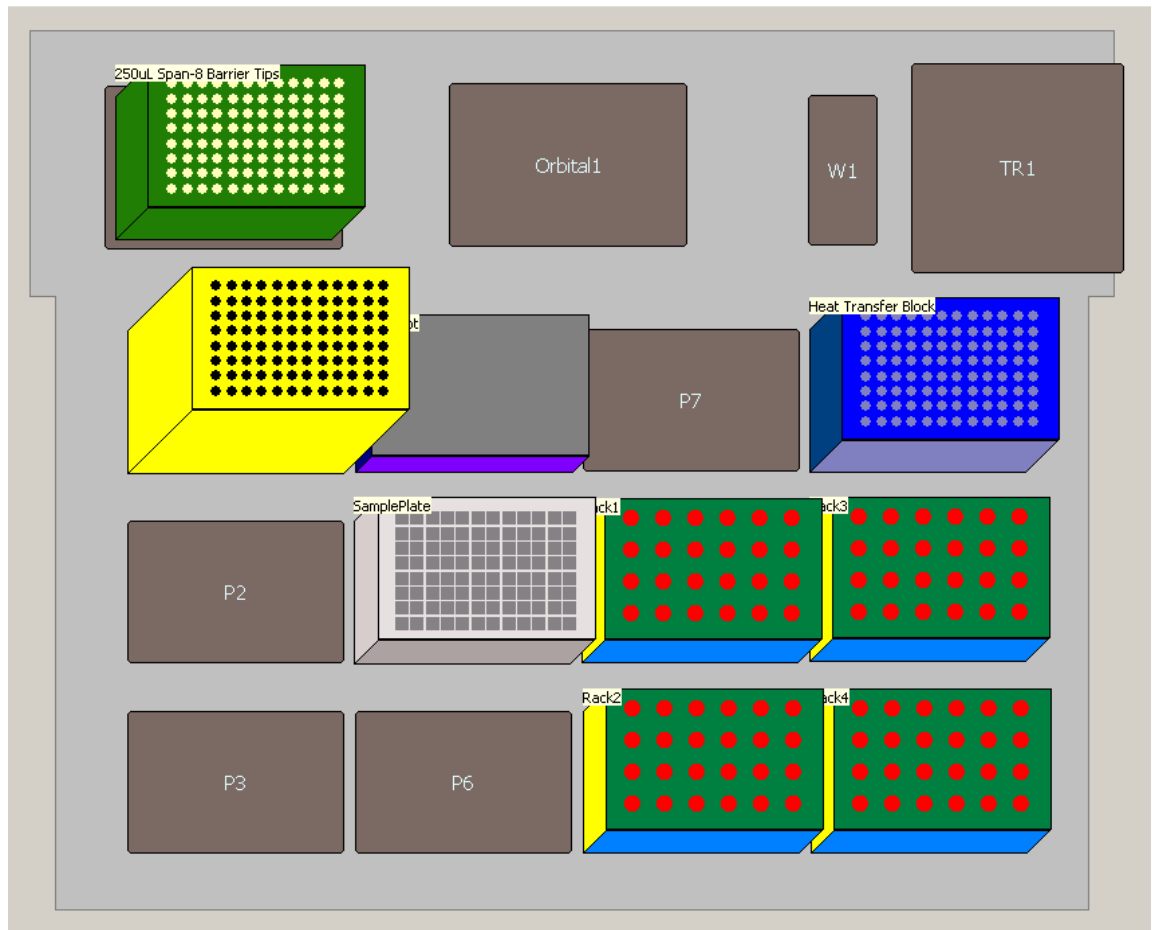
- 5.8.2.2.2. Place the sample in 1.5 ml microcentrifuge tube (See sampling protocols in 2.8.3.4). Each group of samples being extracted shall include reagent blanks (sperm and non-sperm fraction) as the last samples in the batch.
- 5.8.2.2.2.1. For extraction on the Biomek NX^P workstation, samples shall be loaded specifically into Eppendorf Safe-Lock 1.5 ml Tubes or Promega ClickFit 1.5 ml microtubes. Do not use "dolphin-style" or other microcentrifuge tubes.
- 5.8.2.2.3. To the sample add 300 µl of the Master Mix. Vortex and spin briefly in a microcentrifuge or tap the tube to force the cutting into the extraction fluid.
- 5.8.2.2.4. Incubate the sample at 37°C for 2 hours.
- 5.8.2.2.5. Spin briefly in a microcentrifuge to force the condensate into the bottom of the tube.
- 5.8.2.2.6. Using a wooden applicator stick, remove the cutting and spin in a microcentrifuge for about 5 minutes at approximately 14,000 rcf.
- 5.8.2.2.7. Alternately transfer the cutting into a spin basket insert. Place the basket insert into the tube containing the stain extract. Spin in a microcentrifuge at approximately 14,000 rcf for about 5 minutes. Remove and discard the basket insert.
- 5.8.2.2.8. While being very careful to not disturb any pelleted material, remove the supernatant to a clean, labeled 1.5 ml microcentrifuge tube. This is the non-sperm fraction. Analysis of the non-sperm cell fraction resumes at 5.8.2.2.11. The pellet remaining in the tube is the sperm cell pellet.
- 5.8.2.2.9. Wash the sperm cell pellet by resuspending it in 500 µl digest/wash buffer, vortexing the suspension briefly, and spinning the tube in a microcentrifuge at approximately 14,000 rcf for about 5 minutes. Remove and discard the supernatant fluid, being careful not to disturb the cell pellet.
- 5.8.2.2.10. Repeat step 5.8.2.2.9 four times for a total of five washes. Approval from the Technical Leader, documented in the case record, is required to use less than the five washes.
- 5.8.2.2.11. Lysis buffer step
- 5.8.2.2.11.1. For each sample pair (sperm and non-sperm fraction) combine 600 µl of Lysis Buffer with 6 µl of 1M DTT.
- 5.8.2.2.11.2. Add 400 µl of the Lysis Buffer master mix to each sperm fraction sample and 200 µl to each non-sperm fraction sample.
- 5.8.2.2.12. Vortex sample and spin down briefly. Cut the hinge of the sample tube.
- 5.8.2.2.13. Save until ready for automated DNA extraction. Do not refrigerate or freeze sample. Prior to submission to the automation team, processed samples may be left at room temperature (22-25°C) overnight, if necessary.

5.8.3. Biomek NX^P Preparation

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 5.8.3.1.** Wipe down the deck with 70% ethanol or 10% bleach.
 - 5.8.3.2.** Ensure that the workstation trash is not full.
 - 5.8.3.3.** Ensure that the waste carboy is not full.
 - 5.8.3.4.** Ensure that there is enough distilled water in the intake carboy (the valve must be underwater).
 - 5.8.3.5.** Ensure that the software is connected to the instrument and not in Simulate mode:
 - 5.8.3.5.1. "Instrument" menu → "Hardware Setup"
 - 5.8.3.5.2. Set Port option to "COM1"
 - 5.8.3.5.3. Click "Reconnect" and then "Accept."
 - 5.8.3.6.** Run "Home All Axes" under the Instrument menu.
 - 5.8.3.6.1. Let the tips flush until there are no bubbles created when the pistons move.
 - 5.8.3.6.2. There may be a large bubble stationary at the tops of the syringes; this is normal.
 - 5.8.3.7.** Ensure that ethanol and isopropyl alcohol have been added to the alcohol wash buffer in the DNA IQ kit.
- 5.8.4. Initial Tube Transfer**
- 5.8.4.1.** Place sample tubes in the tube racks (4x6 with white adapters), arranging the tubes according to the order shown in the Biomek Workbook. Do not skip columns or spaces between samples.
 - 5.8.4.2.** Ensure that the sample tube lid hinges have been cut.
 - 5.8.4.3.** Spin down the tube racks (containing the sample tubes) in the centrifuge. Carefully remove the sample tube lids and discard.
 - 5.8.4.3.1. CAUTION: Once the lids are removed, the Biomek Workbook is the only record of the order and identity of each sample.
 - 5.8.4.4.** Arrange the deck layout as shown in the figure below:
 - 5.8.4.4.1. Place sample tube racks on positions P8, P9, P11, and P12, again paying attention to sample order according to the Biomek Workbook.
 - 5.8.4.4.2. Place a new Promega (Madison, WI) 2.2 ml Square-Well Deep Well Plate (Cat. no. V6781) on position P5. Orient the plate so that the clipped corner is on the bottom left.
 - 5.8.4.4.3. Place a new box of Beckman Coulter (Fullerton, CA) Biomek® P250 Span-8 Barrier Tips (Cat. no. 379503) on the Rapid-Shuck module (top left).

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



5.8.4.5. Open the "Initial Tube Transfer" method contained in the Promega project.

5.8.4.6. Click the green "Run" button at the top of the screen.

5.8.4.7. The method will prompt for two values:

5.8.4.7.1. SampleColumns = the number of full or partial columns of sample on the extraction plate.

5.8.4.7.1.1. *Example: 20 samples/blanks will use two full columns and half of a third. Enter "SampleColumns" as 3.*

5.8.4.7.2. SampleVolume = the approximate volume of liquid in the sample tubes, in microliters. Round to the next highest hundred microliters, to a maximum of 400 ul.

5.8.4.7.2.1. *Example: Most of the sample tubes contain 300 ul, but one tube contains 340 ul. Enter "SampleVolume" as 400.*

5.8.4.8. When the instrument has finished transferring sample from the tubes to the sample plate, remove the tube racks from the deck and discard the empty sample tubes.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

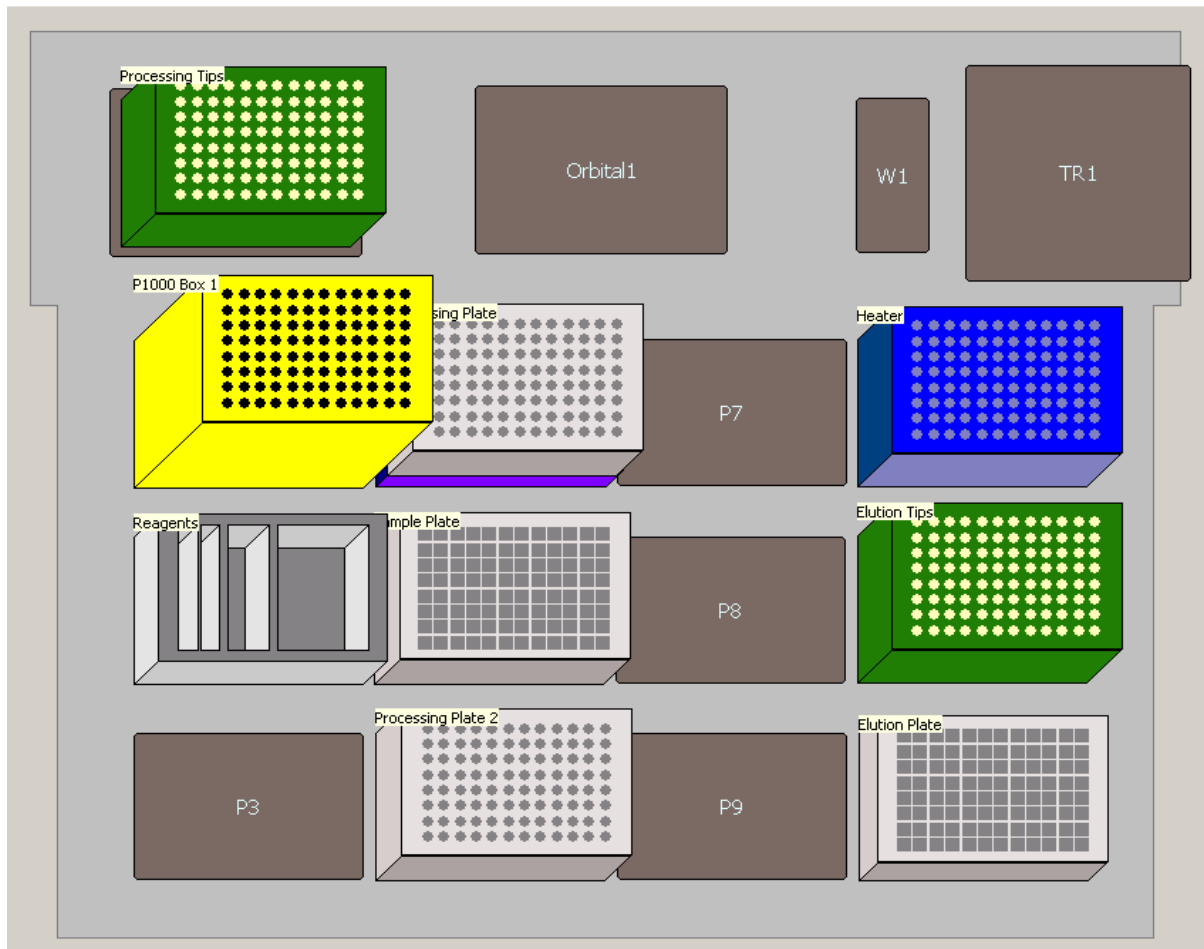
- 5.8.4.9.** Leave the used P250 Span-8 Barrier Tips on the Rapid-Shuck module for subsequent use in DNA IQ automated extraction. Each tip is now associated with a single sample and will only be used to pipet that sample.
- 5.8.4.10.** Remove the 2.2 ml Square-Well Deep Well Plate [containing sample transferred during Initial Tube Transfer (5.8.4)] and cover with a temporary seal. Spin the plate using either a centrifuge or a salad spinner to remove any bubbles and force samples into the bottom of each well.

5.8.5. DNA IQ™ Automated Extraction Procedure

5.8.5.1. Instrument Deck Setup

- 5.8.5.1.1. Turn on the heating block via the switch to the right of the Biomek NX^P, and ensure that temperature is set to 85°C.
- 5.8.5.1.2. Place the 2.2 ml Square-Well Deep Well Plate sample plate [containing sample transferred during Initial Tube Transfer (5.8.4)] on position P5.
- 5.8.5.1.3. The box of P250 Span-8 Barrier Tips used in the Initial Tube Transfer (5.8.4) should be unchanged on the Rapid-Shuck module. DO NOT change the orientation of this box.
- 5.8.5.1.4. Place the following labware on the deck as shown in the figure below:
- 5.8.5.1.4.1. Box of Beckman Coulter Biomek® P1000 Span-8 Tips (Cat. no. 987925) on position P1. If there are fewer than five columns of tips available, the program will prompt for a full box of P1000 tips on position P3, otherwise, a partial box may be used.
 - 5.8.5.1.4.2. Box of new P250 Span-8 Barrier Tips on position P11.
 - 5.8.5.1.4.3. Promega 1.2 ml Round-Bottom Deep Well Plates (Cat. no. V6771) on positions P6 and P4 (aligned on top of the MagnaBot module in P4). Orient each plate so that the clipped corner is on the bottom left.
 - 5.8.5.1.4.4. Promega 1.1 ml Square-Well V-Bottom Deep Well Plate (Cat. no. V6821) on position P12. Orient the plate so that the clipped corner is on the bottom left.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



5.8.5.2. Reagent Setup

- 5.8.5.2.1. Open the Biomek Workbook from the “Robot Team” network folder.
- 5.8.5.2.2. The “Reagents” tab has a description of the reagents and supplies needed to run automated DNA IQ extraction.
 - 5.8.5.2.2.1. Enter the number of samples on the plate, including reagent blanks.
 - 5.8.5.2.2.2. Enter the desired elution volume (between 50-100 μ l per sample).
 - 5.8.5.2.2.3. Do not count the No Template Control (NTC) or quantification standards.
 - 5.8.5.2.2.4. Do not add extra samples for excess volume; it is already calculated into the program.
- 5.8.5.2.3. In a reservoir holder, place the following clean reservoirs in order from left to right: one Quarter Module reservoir (Beckman Coulter, Fullerton CA, cat. no. 372790) divided by height, one additional Quarter Module reservoir, and one Half Module reservoir (Beckman Coulter, cat. no 372786).

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

5.8.5.2.4. Load reagents in each reservoir as indicated in the “Reagents” tab, adding elution buffer last.

5.8.5.2.5. Place the reservoir holder on deck position P2.

5.8.5.3. Running the DNA IQ Method

5.8.5.3.1. Open the “DNA IQ NX Span8_v2.0.0.ISP” method, contained in the Promega project.

5.8.5.3.2. Click the “Run” button at the top of the screen.

5.8.5.3.3. The method will prompt for two values:

5.8.5.3.3.1. UsedP1000TipCols = the number of **used** full or partial columns in the 1000 µl tip box on position P1. For a new box, enter 0.

5.8.5.3.3.1.1. *Example: If two and a half columns of P1000 tips have been used, enter “UsedP1000TipCols” as 3.*

5.8.5.3.3.2. UsedP200TipCols = the number of **used** full or partial columns in the 250 µl tip box on the Rapid-Shuck module. Assuming a new box was used during the Initial Tube Transfer (5.8.4), the value should be 0.

5.8.5.3.4. A plate map interface will appear.

5.8.5.3.4.1. Enter the approximate sample volume.

5.8.5.3.4.2. Enter the desired elution volume between 50 and 100 µl (should match the elution volume entered in the Biomek NX Workbook, above).

5.8.5.3.4.3. Set Sample Type to “Aqueous”

5.8.5.3.4.4. Set “Perform Lysis Wash?” to “Yes.”

5.8.5.3.4.5. Select the wells to be processed.

5.8.5.3.4.5.1. Click on any well in a column to select the entire column.

5.8.5.3.4.5.2. Click/hold on any well and drag the cursor out of the well to select that well only.

5.8.5.3.4.5.3. Hold Ctrl to select separate wells/columns, and Shift to select consecutive wells/columns.

5.8.5.3.4.5.4. Do not select the last two columns (11 & 12). These will always be used for quantification standard.

5.8.5.3.4.5.5. Click “Enter.” The wells you selected will change color.

5.8.5.3.4.6. Step 5.8.5.3.4.5 may be repeated to specify different sample volumes or elution volumes, but doing so will change the amount of reagents required for the run (see Reagent Preparation section and step 5.8.5.3.5.1, below).

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 5.8.5.3.4.7. When all samples have been selected and specified, click “Finished.”
- 5.8.5.3.5. A map of the reagent reservoir will appear.
 - 5.8.5.3.5.1. Unless the sample volumes have been altered, the reagent volumes should match what the Biomek NX Workbook displayed in the Reagent Preparation section, above.
 - 5.8.5.3.5.2. Click “Close Window.”
- 5.8.5.3.6. The protocol will run for approximately 1 hour 45 minutes, depending on how many samples are being processed.
- 5.8.5.3.7. When the run is finished, reservoirs may be carefully rinsed, labeled, and reused. Discard partial tip box from position P11. Remaining partial tip boxes may be used again. Discard processing plates (both 1.2 ml round Round-Bottom Deep Well Plates). Turn off the heating block.
- 5.8.5.3.8. Label and retain the original sample plate (2.2 ml Square-Well Deep Well Plate) containing the lysate, as back-up until the samples have been completely processed. Cover and store at room temperature.
- 5.8.5.3.9. If the elution plate (1.1 ml Square-Well V-Bottom Deep Well Plate) containing the extracted samples is not to be quantified immediately, cover with a temporary seal and refrigerate.

5.8.6. REAL-TIME PCR QUANTIFICATION USING QUANTIFILER® DUO Prepared on the Biomek NX^P Laboratory Automation Workstation

5.8.6.1. Instrument Deck Setup

- 5.8.6.1.1. In the Biomek Software, open the “ABI_Quant+MM+NTC” method contained in the ABI project.
- 5.8.6.1.2. Click on the “User Interface” line within the method.
 - 5.8.6.1.2.1. To the right, check that “Quantifiler Duo” is selected.
 - 5.8.6.1.2.2. Enter the number of samples to process (equal to the number of elution plate wells that contain extract).
 - 5.8.6.1.2.3. Do not count the NTC or quantification standards.
 - 5.8.6.1.2.4. Do not add extra samples for excess volume; it is already calculated into the program.
- 5.8.6.1.3. Place the following labware on the deck as shown in the figure below:
 - 5.8.6.1.3.1. New box of Beckman Coulter Biomek® P50 Barrier Tips (Cat. no. A21586) on position P2. Alternatively, a partial box may be used by selecting the number

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

and position of remaining tips in the box under the “Properties” tab of the “Instrument Setup” step.

- 5.8.6.1.3.2. Box of P250 Span-8 Barrier Tips on position P1. Note: The last two columns of elution tips from the DNA IQ method can be used here; turn the box around so that the tips are in the two leftmost columns.
- 5.8.6.1.3.3. New Applied Biosystems (Foster City, CA) MicroAmp® Optical 96-Well reaction plate (Cat. no. N801-0560) on position P11.
- 5.8.6.1.3.4. The elution plate containing extracted samples on position P12.



5.8.6.2. Reagent Preparation

- 5.8.6.2.1. Open the Biomek NX Workbook from the RobotTeam folder.
- 5.8.6.2.2. The “Reagents” tab has a description of the reagents and supplies needed to run automated quantification setup.
 - 5.8.6.2.2.1. Enter the number of samples on the plate, the same as entered into the “User Interface” above.
- 5.8.6.2.3. Prepare the master mix as described in section 2 of the Forensic Biology Section Casework Test Method, using the volumes indicated on the Reagents tab. Note that for 40 or more samples, the master mix must be divided evenly into two tubes. Vortex the Master Mix 3 to 5 seconds, then centrifuge briefly.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 5.8.6.2.4. Place the master mix tube(s) in wells A6 (and B6) of the Reagent Tube Rack as indicated below.
- 5.8.6.2.5. Prepare the standard dilution series as described in section 2 of the Forensic Biology Section Casework Test Method, or use a previously prepared dilution series. Each tube must contain at least 20 µl of standard.
- 5.8.6.2.6. Place the standard tubes in columns 2 and 3 of the Reagent Tube Rack as indicated below.
- 5.8.6.2.7. Open and fold back all tube caps and place the Reagent Tube Rack on deck position P8.

	1	2	3	4	5	6
A		Standard 1	Standard 5			Master Mix
B		Standard 2	Standard 6			Master Mix
C		Standard 3	Standard 7			
D		Standard 4	Standard 8			

5.8.6.3. Running the Automated Quant Duo Setup Method

- 5.8.6.3.1. With the “ABI_Quant+MM+NTC” method open and the number of samples specified, click the “Run” button at the top of the screen.
- 5.8.6.3.2. A window will appear to confirm the amount and placement of the master mix tubes. Click “OK.”
- 5.8.6.3.3. A window will appear to confirm the deck layout as shown by the software. Click “OK.”
- 5.8.6.3.4. A window will appear to confirm the total amount of master mix, the amount of standard in each of the standard tubes, the sample count, and the quantification kit. Click “OK.”
- 5.8.6.3.5. The protocol will begin. When the run is finished, remove the elution plate with extracts and cover with a temporary seal until ready to proceed with amplification.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 5.8.6.3.6. Seal the optical plate with an optical adhesive cover. Run the edge of the cover applicator between the rows and columns of the wells to ensure that all wells are sealed properly.
- 5.8.6.3.7. Spin the plate using either a centrifuge or a salad spinner to remove any bubbles and force samples into the bottom of each well.
- 5.8.6.3.8. Place the plate in the real-time PCR instrument, turn on the instrument, and open the 7500 System software.

5.8.6.4. Create A Plate Document

- 5.8.6.4.1. On the Biomek computer, open the Biomek NX Workbook containing the set of samples being run, and click on the “RT1 Export” tab. If you have made any recent changes, save them now.
- 5.8.6.4.2. Select Save As→Other Formats. Open the Robot Team folder and select Save as type: “Text (Tab delimited)”. Save the file.
- 5.8.6.4.3. Two alert windows will appear in Excel; click “OK” for the first and “Yes” for the second. Close the Biomek NX Workbook without making any further changes or saving again.
- 5.8.6.4.4. On the computer connected to the real-time PCR instrument, create a new plate document as described in the DNA Methods Manual.
- 5.8.6.4.5. Select File→Import Plate Setup. Import the text file you created in the Robot Team folder. The wells should populate with the names of the samples and standards.
- 5.8.6.4.6. Save the plate document and proceed with real-time PCR analysis as described in section 2 of the Forensic Biology Section Casework Test Method.

5.8.7. PowerPlex® 16 Hot-Start Amplification Prepared on the Biomek NX^P Laboratory Automation Workstation

5.8.7.1. Vortexing Extracts

- 5.8.7.1.1. Prior to amplification, the extract plate (the elution plate from the DNA IQ procedure) shall be vortexed on the Orbital Shaker module to ensure uniform pipetting of sample.
- 5.8.7.1.2. Spin down the extract plate to remove any condensation from the temporary seal.
- 5.8.7.1.3. In the Biomek Software, select “Instrument Menu” → “Manual Control.”
- 5.8.7.1.4. Select the “Modules” menu and choose “Orbital Shaker.”
- 5.8.7.1.5. Place the extract plate on the Orbital Shaker, with the temporary seal in place.
 - 5.8.7.1.5.1. If the Orbital Shaker is clamped, change the command to “Unclamp” and click “Go.”

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

5.8.7.1.6. Change the command to “Timed shake.”

5.8.7.1.6.1. Enter 15 seconds for the time.

5.8.7.1.6.2. Enter 800 RPM for the speed.

5.8.7.1.6.3. Click “Go.”

5.8.7.1.7. Change the command to “Unclamp.” Click “Go.”

5.8.7.1.8. Remove the extract plate from the Orbital Shaker.

5.8.7.1.9. Spin down the extract plate again before proceeding to amplification set-up.
(CAUTION: Ensure that there are no bubbles in the wells.) Remove temporary seal.

5.8.7.2. Instrument Deck Setup

5.8.7.2.1. Open the “NormSTR_NXP_v1.0.0.ISP” method contained in the Promega project.

5.8.7.2.2. Place the following labware on the deck as shown in the figure below:

5.8.7.2.2.1. Box of P250 Span-8 Barrier Tips on the Rapid-Shuck module.

5.8.7.2.2.2. Box of P50 Barrier Tips on position P1. A second box of P50 Barrier Tips may be required on position P3.

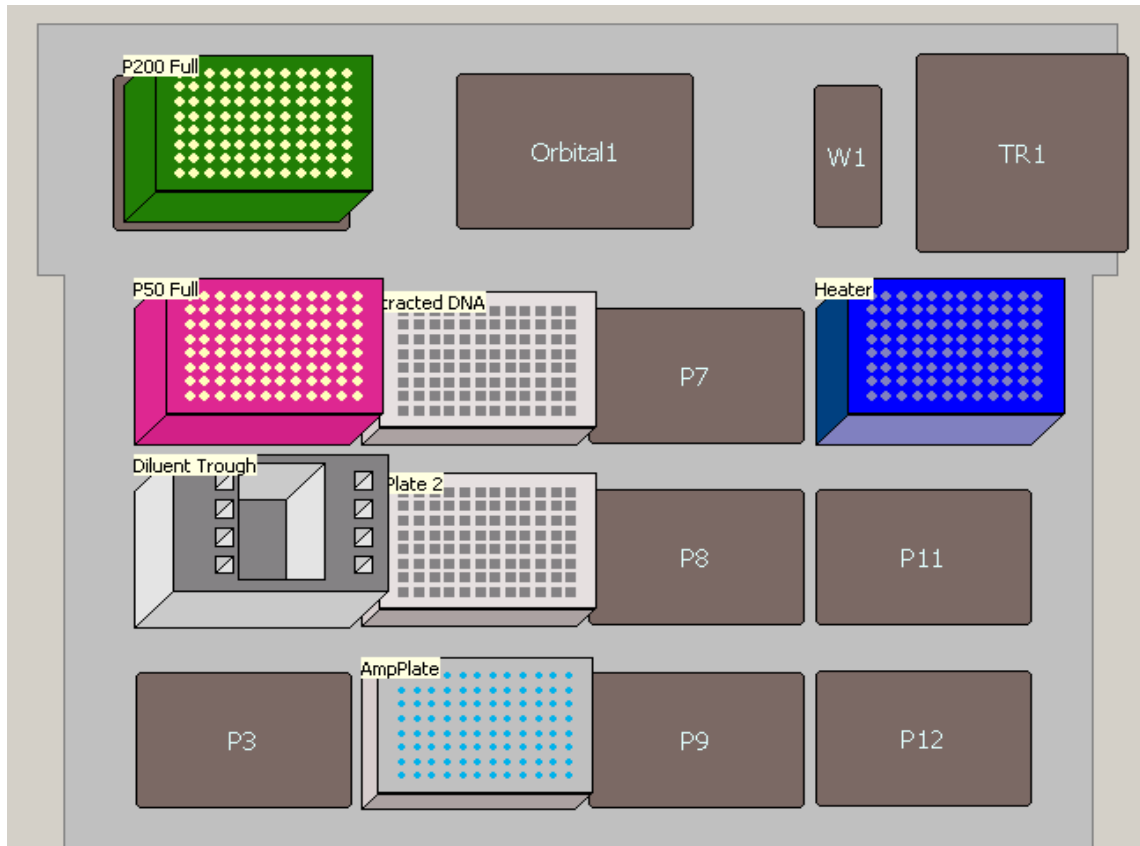
5.8.7.2.2.3. 1.1 mL square-bottom deepwell plate on position P5. A second 1.1 mL square-bottom deepwell plate may be required on position P8.

5.8.7.2.2.4. New 96-well optical amplification plate on position P6.

5.8.7.2.2.5. Extract plate containing samples on position P4.

5.8.7.2.2.5.1. CAUTION: ensure that the MagnaBot module has been removed.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



5.8.7.2.3. Click “Run.”

5.8.7.2.4. The program will prompt for three values:

5.8.7.2.4.1. First_P250_Tip = the number of the first unused tip in the 250µL tip box on the Rapid-Shuck module, numbering down columns and then across. Do not use a tip box with fewer than two columns of tips remaining. For a new box, enter 1.

5.8.7.2.4.1.1. *Example: If two and a half columns (twenty tips) of P250 tips have been used, enter “First_P250_Tip” as 21.*

5.8.7.2.4.2. First_P50_Tip = the number of the first unused tip in the 50 µl tip box on position P1, numbering down columns and then across. For a new box, enter 1.

5.8.7.2.4.3. Manual_MM_Prep =

5.8.7.2.4.3.1. Enter “True” (case sensitive) if you will prepare the master mix yourself by combining Primer Pair Mix and Reaction Mix from the PowerPlex®16 HS kit.

5.8.7.2.4.3.2. Enter “False” (case sensitive) if you would like the Biomek NX^P to prepare the master mix automatically.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

5.8.7.2.4.3.2.1. NOTE: Ensure that there is sufficient Primer Pair Mix and Reaction Mix in each tube.

5.8.7.3. Normalization Manager

- 5.8.7.3.1. Login to the Normalization Manager with your username and password.
- 5.8.7.3.2. Enter a unique name for the amplification run, according to the batch number.
- 5.8.7.3.3. Select an analysis template according to the desired target input DNA to be amplified. Click "Next."
- 5.8.7.3.4. Select the "Blanks_template" extraction control template. Click "Next."
- 5.8.7.3.5. Select the "Default_3500" for use with the 3500xL. Click "Next."
- 5.8.7.3.6. Browse for the appropriate .csv file exported by the 7500 System Software. Click "Open" and then "Next."
- 5.8.7.3.7. Click "Review Extraction Plate" to check the samples that have been imported.
 - 5.8.7.3.7.1. Wells that will **not** be amplified are colored gray or dark gray.
 - 5.8.7.3.7.2. Any wells with a name containing "RB" should be orange (extraction control) and will be amplified unless otherwise specified.
 - 5.8.7.3.7.3. Turn off amplification of appropriate samples by selecting the well and clicking "Amplify: No" at the lower left.
 - 5.8.7.3.7.4. Turn off amplification of appropriate reagent blanks by clicking "Mark as Sample" at the top and then "Amplify: No" at the lower left.
 - 5.8.7.3.7.5. When the appropriate samples have been selected for amplification, click "Done" and then "Next."
- 5.8.7.3.8. Click "Review Amplification Plate" to check the re-arrangement of samples to be amplified.
 - 5.8.7.3.8.1. Samples that will not be amplified have been removed.
 - 5.8.7.3.8.2. Injection controls (AB, PC, and ladders) have been added.
 - 5.8.7.3.8.3. The remaining samples to be amplified have been re-arranged. This is the final layout of both the amplification plate and the CE plate.
 - 5.8.7.3.8.4. Delete extra ladders (such as at the end of a half-full plate) by right-clicking them.
 - 5.8.7.3.8.4.1. CAUTION: For 3500xL setup, wells H3, A6, H9, and A12 must never contain samples. These wells will have ladders automatically added during the CE Setup step using the Biomek 3000.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

5.8.7.3.8.5. When you are satisfied with the amplification plate, click “Done” and then “Next.”

5.8.7.3.9. Select the desired CE Instrument Injection Protocol from the drop-down list. Additional protocols, if desired, may be added in the CE Instrument Software.

5.8.7.3.10. Re-enter your username and password when requested, and click “Finish.”

5.8.7.3.11. The Normalization Manager will exit automatically and the protocol will continue in the Biomek Software.

5.8.7.4. Reagent Preparation

5.8.7.4.1. Follow the prompts within the Biomek Software. Note that depending on the data loaded in the Normalization Manager step, the protocol may require an additional 1.1 ml square-bottom deepwell plate on position P8.

5.8.7.4.2. If you have opted for the Biomek NX^P to prepare the STR Master Mix automatically, follow the prompts.

5.8.7.4.3. If you are making your STR Master Mix manually, a prompt will provide the required volumes for each component.

5.8.7.4.4. Place the STR Master Mix tube in position 4 (front-most) of the Left Tube Holder on the reagent rack.

5.8.7.4.5. Place the tube containing diluted positive control (at least 20 µl) in position 1 (rear-most) of the Right Tube Holder on the reagent rack. Click “OK.”

5.8.7.4.6. Pipet the indicated amount of amplification-grade water or nuclease-free water into the center trough of the reagent rack. Place the reagent rack on deck position P2.

5.8.7.5. Running the Normalization/Amp Set-up Method

5.8.7.5.1. Check that the deck layout matches the layout indicated in the next prompt. Click “OK.”

5.8.7.5.2. The run will begin, performing normalization and amplification setup in one step.

5.8.7.5.3. When the run is finished, remove the amplification plate and cover with adhesive foil. Press the foil well using a roller tool.

5.8.7.5.4. Remove the elution plate containing extracted samples and cover with a temporary seal and refrigerate.

5.8.7.6. Create and Export Amp/CE Plate Record

5.8.7.6.1. Open the “*platenamename*_CEReport” text document created by the Normalization Manager, contained in the folder “AnalysisRunPerformed.” Select All and copy.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 5.8.7.6.2. Open the Biomek Workbook containing the set of samples that have been run, and click on the “Amp Plate Import 1” tab. Click on the red cell in the upper-left corner, and paste.
- 5.8.7.6.3. Click on the “Amp Plate View” tab. The sample names and locations have been imported to the plate worksheet, and the plate name and operator have been filled in.
- 5.8.7.6.4. Click on the “Insert Cases” button. The case numbers for all samples on the plate are compiled in the “Cases” box.
- 5.8.7.6.5. Fill out the rest of the worksheet as designated, including dates, reagent lot numbers, amplification reaction type, and injection protocols.
- 5.8.7.6.6. Save the completed worksheet as a .pdf file.

5.8.8. Preparing a 3500 plate on the Biomek 3000

5.8.8.1. Biomek 3000 Preparation

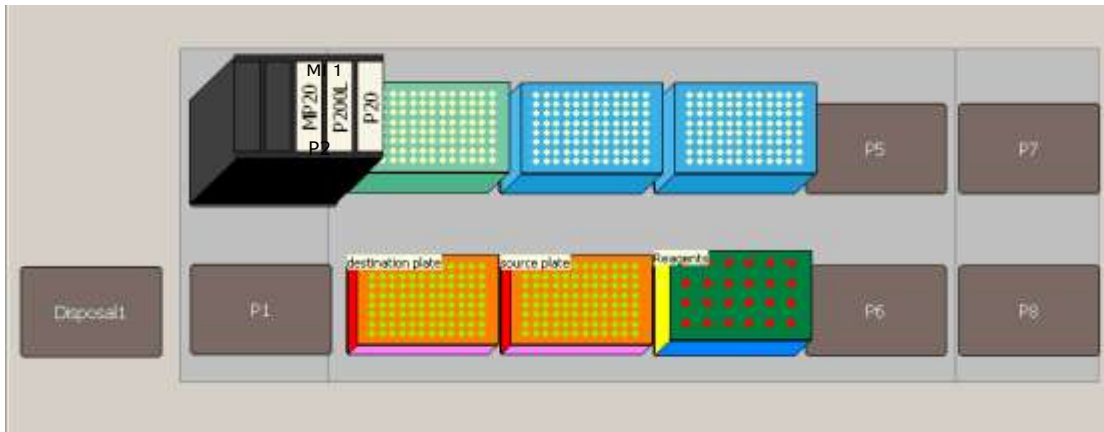
- 5.8.8.1.1. Open the “Biomek Software” located on the desktop.
- 5.8.8.1.2. Calibrate the Biomek 3000 prior to operation.
- 5.8.8.1.3. All tubes of allelic ladder in the post-amplification kit shall be combined into a single 1.5 ml Eppendorf microcentrifuge tube or Promega 1.5 ml ClickFit microtube (do not use a “dolphin”-style tube), marked as “ladder” with associated lot numbers recorded on the tube, and stored with the kit when not in use.

5.8.8.2. Instrument Deck Setup

- 5.8.8.2.1. Click File → Open, select “3500_Direct_transfer_with_ladder” for 3500xL setup.
 - 5.8.8.2.1.1. This will open the designated program that will transfer a plate with dedicated ladder positions into the A6, A12, H3, and H9 positions for 3500xL setup.
- 5.8.8.2.2. Place the following labware on the deck as shown in the figure below:
 - 5.8.8.2.2.1. Box of Beckman Coulter Biomek® AP96 P250 Tips (Cat. no. 717253) on the ML1 position.
 - 5.8.8.2.2.2. Two boxes of Beckman Coulter Biomek® AP96 P20 Tips (Cat. no. 717256) on the ML2 and ML3 positions.
 - 5.8.8.2.2.2.1. Note: A typical plate setup will utilize one P250 tip, eight P20 tips per column transferred, and between one and six P20 tips for ladder transfers. Ensure that enough tips are available before proceeding.
 - 5.8.8.2.2.3. One new 96-well optical plate at position P2.
 - 5.8.8.2.2.3.1. This is the CE plate where master mix and samples will be loaded when the program has finished.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 5.8.8.2.2.4. Spin down the amplification plate and ensure that no bubbles remain. Place the plate in deck position P3. Secure the amplified plate to the plate rack with tape.



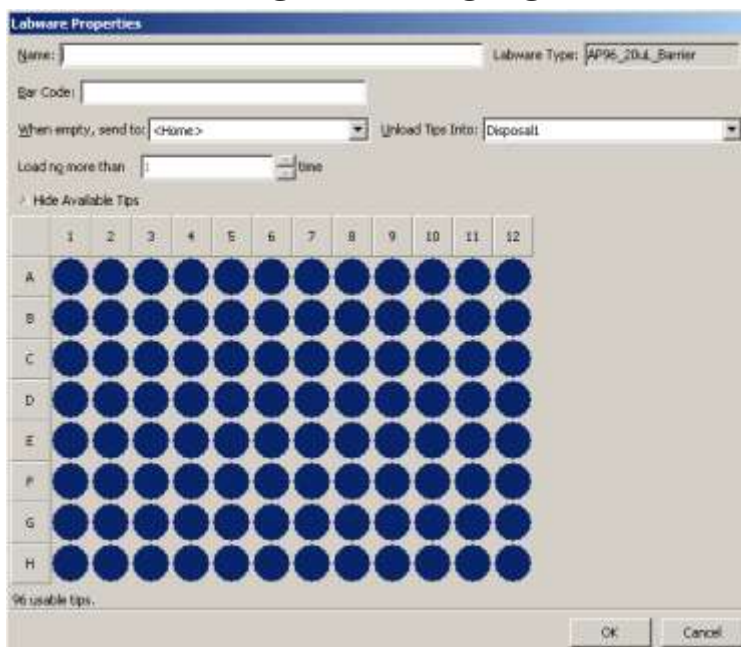
- 5.8.8.2.3. In the software program, click the “Instrument Setup” step, which will bring up the Deck Display.
- 5.8.8.2.4. Right-click on P250 box in position ML1 and select “Properties” to open the “Labware Properties” menu as shown below.
- 5.8.8.2.5. Ensure that the “Unload Tips Into:” drop down menu is selected as “Disposal1”, the “When empty, send to:” drop down menu is selected as “<Home>”, and the “Load no more than” drop down menu is designated as “1”.

The screenshot shows the 'Labware Properties' dialog box. It contains the following fields and settings:

- Name:** (empty text field)
- Labware Type:** AP96_200uL_Barrier
- Bar Code:** (empty text field)
- When empty, send to:** <Home>
- Unload Tips Into:** Disposal1
- Load no more than:** 1 time
- Show Available Tips:** (checked)
- Buttons:** OK, Cancel

- 5.8.8.2.6. Select “Show Available Tips” as shown below.
- 5.8.8.2.7. By clicking on individual tip locations, you may designate whether tips are present (blue) or absent (white). For every location where a tip is absent from the physical deck, click the appropriate location to turn that location white. You may reference the bottom left corner of the menu to determine the number of available tips that are being designated as usable.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



5.8.8.2.8. Configure Labware Properties and available tips for the P20 boxes located at positions ML2 and ML3 in the Deck Layout.

5.8.8.3. Reagent Preparation

5.8.8.3.1. To prepare master mix for automated dispensing by the Biomek 3000:

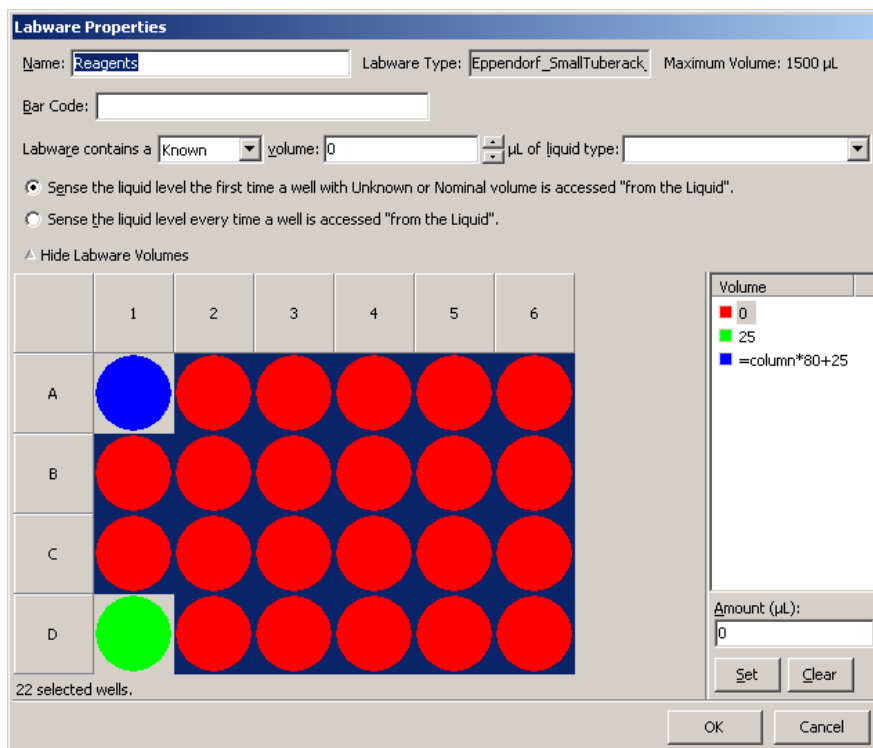
5.8.8.3.2. In a 1.5 ml Eppendorf microcentrifuge tube or Promega 1.5 ml ClickFit Microtube, prepare the appropriate volume of master mix (Hi-Di and ILS) for the associated number of samples and/or columns (see example chart below for 1.0 μ l ILS/sample).

Number of Samples+Ladders	Number of Columns	ILS (ul) (1.0 ul/sample)	Hi-Di (ul)	Total (ul)
1-16	2	18	162	180
17-32	4	34	306	340
33-48	6	50	450	500
49-64	8	66	594	660
65-80	10	82	738	820
81-96	12	98	882	980
1-24 (3500xL)	3	26	234	260
25-48 (3500xL)	6	50	450	500
49-72 (3500xL)	9	74	666	740
73-96 (3500xL)	12	98	882	980

5.8.8.3.2.1. Do not use a “dolphin”-style microcentrifuge tube, or the robot may fail to load master mix accurately to the columns.

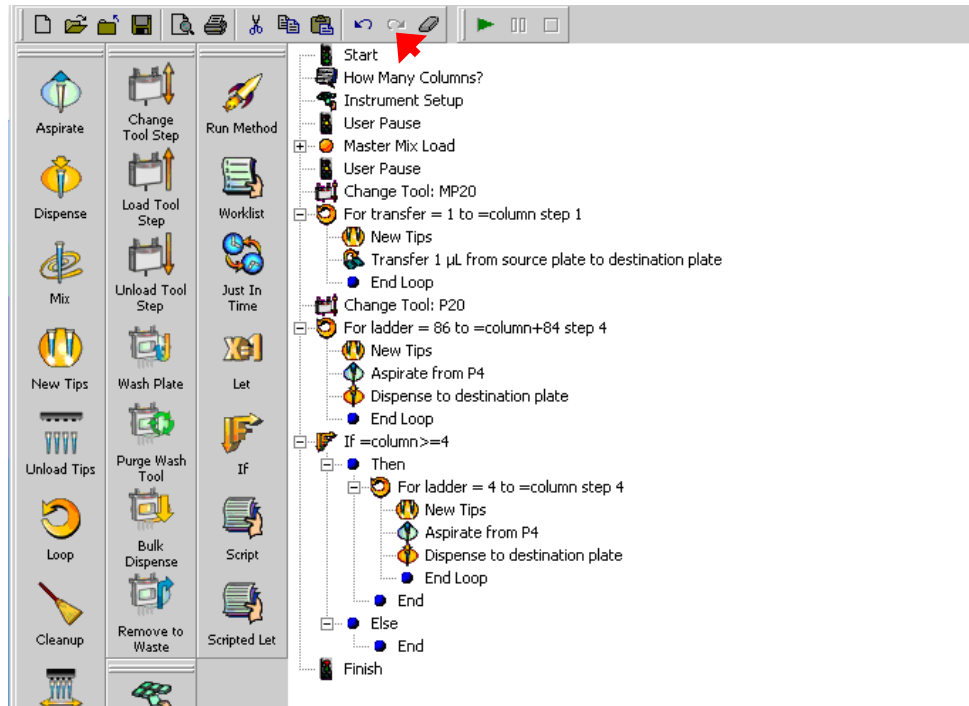
INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 5.8.8.3.2.2. Ensure that sufficient master mix is prepared to cover all capillaries during electrophoresis, or manually pipet Hi-Di into empty wells after the plate is complete.
- 5.8.8.3.3. Vortex and spin down, ensuring that no bubbles remain.
- 5.8.8.3.4. Place the prepared master mix tube in position A1 of the 24-well tube rack located in position P4 on the Deck, as shown in blue below.



- 5.8.8.3.5. Vortex and quickly spin down the combined tube of allelic ladder and ensure that no bubbles remain.
- 5.8.8.3.6. Place the tube of ladder in position D1 of the 24-well tube rack located in position P4 on the Deck, as shown in green above.
- 5.8.8.4. Starting the CE Plate Set-up Run**
- 5.8.8.4.1. Remove all lids from tip boxes and from the tubes of prepared master mix and ladder and place them clear of the deck.
- 5.8.8.4.2. In the software program, click on the green “run” arrow located on the top command bar, as shown below.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS



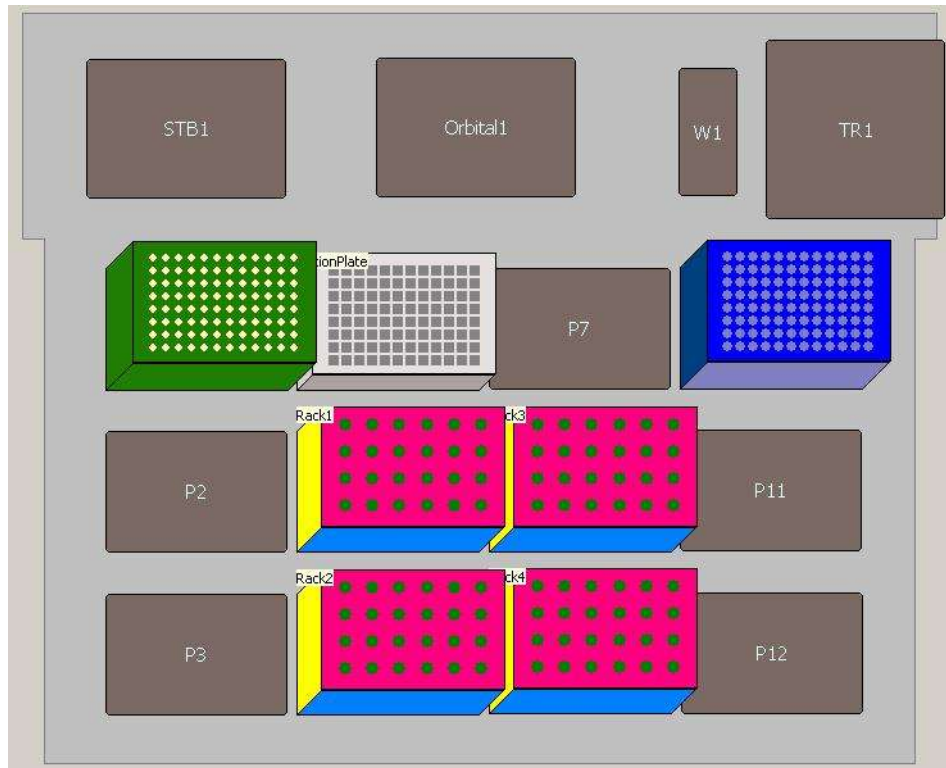
- 5.8.8.4.3. Follow the prompts as they appear. You will be asked to input the number of columns for the plate setup. This number should be the same as originally determined when preparing the master mix (see chart above).
- 5.8.8.4.4. When the program has completed, remove and discard any empty tip boxes.
- 5.8.8.4.5. Discard the master mix tube, and store the allelic ladder tube with the post-amplification kit.
- 5.8.8.4.6. Seal the amplification plate with aluminum foil plate seal and store frozen.
- 5.8.8.4.7. Add a septa cover to the CE plate, and load onto genetic analyzer as described in section 2 of the Forensic Biology Section Casework Test Method.

5.8.9. Final Tube Transfer

- 5.8.9.1. Place new, empty, labeled Molecular BioProducts (San Diego, CA) 1.5 ml screw-top tubes (Cat. no. 3474) in the tube racks (4x6 with white adapters), arranging the tubes according to the order shown in the Biomek Workbook. Do not skip columns or spaces between samples.
- 5.8.9.2. Arrange the deck layout as shown in the figure below:
 - 5.8.9.2.1. Place sample tube racks on positions P5, P6, P8, and P9, again paying attention to sample order according to the Biomek Workbook.
 - 5.8.9.2.2. Place the plate containing extracted samples on position P4.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 5.8.9.2.3. Place a new box of Beckman Coulter Biomek® P250 Span-8 Barrier Tips on position P1.



- 5.8.9.3. Open the “Final Plate to Tube Transfer” method contained in the Promega project.

- 5.8.9.4. Click the green “Run” button at the top of the screen.

- 5.8.9.4.1. The method will prompt for a value equaling the number of full or partial columns of sample on the extraction plate.

- 5.8.9.4.1.1. *Example: 20 samples/blanks will use two full columns and half of a third.
Enter “SampleColumns” as 3.*

- 5.8.9.5. When the instrument has finished transferring sample from the extraction plate to the tubes, remove the tube racks from the deck, cap the screw-top tubes, and discard the empty sample plate.

- 5.8.10. When processing is completed, the submitting analyst will be notified by e-mail that the data is available on the DNA server and the extracted DNA samples can be retrieved from a designated location.

5.9. Records

- 5.9.1. N/A

5.10. Interpretation of Results

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

5.10.1. N/A

5.11. Report Wording

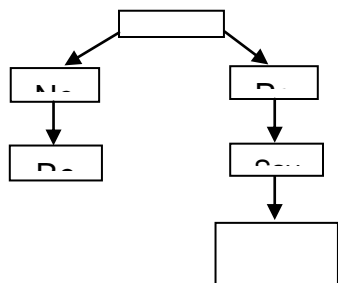
5.11.1. N/A

5.12. References

5.12.1. N/A

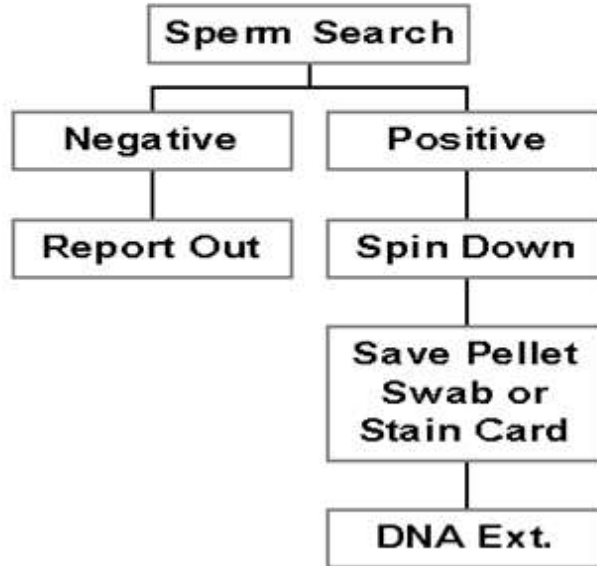
**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS
APPENDIX 1
SEROLOGY FLOW CHARTS**

**Smear Slides
Semen Identification**

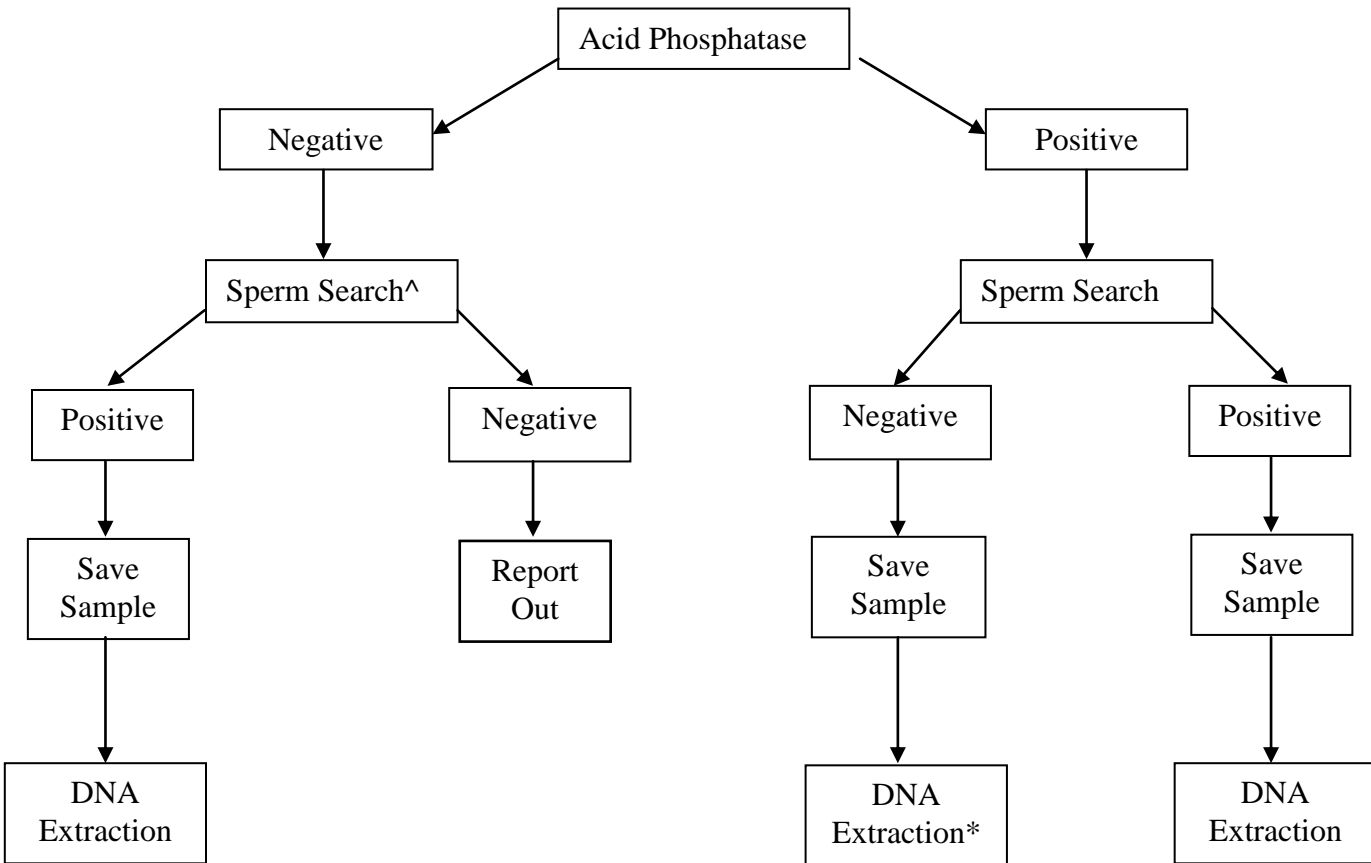


**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS**

**Vaginal Wash
Semen Identification**



**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS
Swabs for Semen Identification**



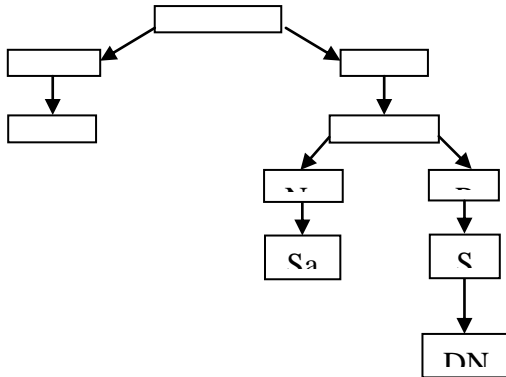
* Optional when other samples extracted.

^ Optional for speculum swabs

Amylase testing may be performed at analyst's discretion.

Dental floss, swabs indicated as bite mark or dried secretions swabs, and any swabs collected from male genitalia may be sent directly to DNA analysis. Other exceptions shall have Supervisor's Approval.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS Other Items (e.g. clothing, bedding, etc.) for Semen Identification



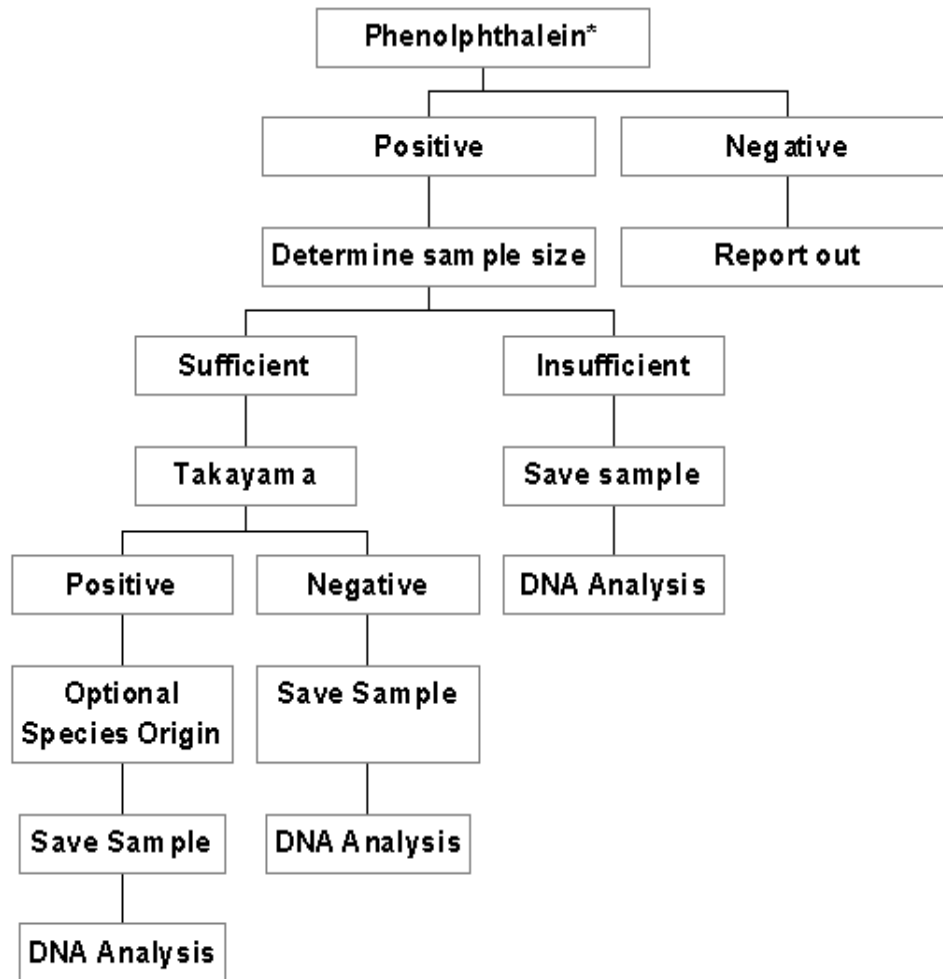
DN

*If the Acid Phosphatase test is the only positive result, the sample should be sent for DNA analysis.

Amylase testing may be performed at analyst's discretion.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Blood Identification



*: If sample will be consumed by performing the phenolphthalein test, the sample may be sent directly for DNA analysis with out testing.

**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS
APPENDIX 2**

ASSUMED TWO PERSON MIXTURE INTERPRETATION

Introduction

An assumed two person mixed DNA profile can be classified as a mixture demonstrating a single major contributor and a single minor contributor, a mixture with a known contributor, or an indistinguishable mixture.

Determining the Mixture Ratio

The average mixture ratio shall be calculated for all assumed two person mixtures unless an assumed contributor is present and is determined to be flipping from the major to minor portion of the mixture (see “Deducing a Foreign Profile Using a Known Contributor”).

Mixture ratios shall be reported to three significant figures, with no rounding.

The IndySTR program will automatically calculate the mixture ratio as described below to provide an estimate of the average mixture ratio to be used to aid in interpretation of the profile. The IndySTR program cannot account for possible peaks in stutter position during this calculation.

If a known/assumed contributor is present and a foreign profile is being deduced, genotype pairings for the mixture ratio calculations shall be done by hand using the assumed genotype. Refer to the section “Deducing a Foreign Profile Using a Known Contributor” for instruction on the calculation.

Two or More Loci Demonstrating Four Alleles

Calculate the average mixture ratio using all loci demonstrating four alleles. The mixture ratio of four allele loci shall be calculated using the formula:

$$\frac{(\text{sum of the largest alleles})}{(\text{sum of the smallest alleles})}$$

One Locus Demonstrating Four Alleles

Calculate the average mixture ratio using the single four allele locus (using the formula above) and the ratios of all the three allele loci using the following formulas (scenario alleles are designated A-C in descending RFU value):

Three allele loci demonstrating a heterozygous predominant contributor

Scenario #1 PHR for $B/A \geq 0.65$ and $C/B < 0.65$

Scenario #2 PHR for $B/A < 0.65$, $C/B < 0.65$, and $(B+C)/A \geq 0.65$

$$\frac{[(\text{sum of the two largest alleles}) - \text{the smallest allele}]}{2(\text{the smallest allele})}$$

Three allele loci demonstrating a homozygous predominant contributor

Scenario #3 PHR for $B/A < 0.65$ and $(B+C)/A < 0.65$

$$\frac{\text{the largest allele}}{(\text{sum of the two smallest alleles})}$$

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Three allele loci demonstrating no predominant contributor or a predominant contributor of unknown zygosity shall not be included in the average mixture ratio calculation.

Scenario #4 PHR for $B/A \geq 0.65$ and $C/B \geq 0.65$

Scenario #5 PHR for $B/A < 0.65$, $C/B \geq 0.65$, and $(B+C)/A \geq 0.65$

No Loci Demonstrating Four Alleles

Calculate the average mixture ratio using all the loci demonstrating three alleles, using the formulas detailed above.

Single Source Major Profile With A Single Source Minor Profile

Interpretation

In order to determine a major and minor profile, the average mixture ratio shall be at least 3:1.

A minimum of 8 loci (not including Amelogenin) are required for a major profile. Exceptions require approval of a supervisor and notification to the Technical Leader, which shall be documented in the case record.

Peaks \leq the established stochastic threshold shall not be included in a major profile.

The minor profile shall be treated as a single source profile. There is no minimum number of loci required for determination of a minor profile and conclusions shall be reported for all results.

Peaks designated as possible alleles in stutter position shall be considered during the interpretation of the minor profile.

If a single allele is present in the minor profile, the following nomenclature shall be used:

M (i.e. 9, M): Use when one allele of the minor profile is known but the sister allele may be masked. (i.e. No allelic dropout is suspected at the locus). When comparing the profile, the standard shall contain a genotype consisting of the alleles present at the locus and at least one of them shall be the designated minor allele. If a standard has the designated minor allele, but the sister allele is not present within the mixture alleles, the standard shall be excluded as a contributor.

A (i.e. 9, A): Use when one allele of the minor profile is known but the sister allele may be any other allele at the locus. (i.e. Allelic dropout is possible at the locus. Therefore, the corresponding sister allele may be either dropped-out or masked.) When a single designated minor allele is \leq the established stochastic threshold, the "A" designation shall be used for the sister allele. When comparing the profile, the standard shall contain the designated minor allele, but any other allele may be present. If a standard does not have the designated minor allele, the standard shall be excluded as a contributor.

The following gives guidance to determine which loci are eligible:

Loci with Four Alleles

If the calculated mixture ratio is $\geq 3:1$ and the peak height ratio of the two highest alleles is ≥ 0.65 , the two highest alleles may be called as the major contributor and the remaining alleles may be called the minor contributor.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

If the calculated mixture ratio is $<3:1$ or the peak height ratio of the two highest alleles is <0.65 , the locus is reported as indistinguishable.

Loci with Three Alleles

Heterozygous Major

If the peak height ratio of the two highest alleles is ≥ 0.65 and the peak height ratio of the smallest allele is <0.33 of each of the other alleles, then report the two largest peaks as the major contributor and the remaining allele as the minor contributor. The sister allele of the minor contributor shall be designated as either an "A" or an "M". If these conditions aren't met, the locus is reported as indistinguishable.

Homozygous Major

If the sum of the two smallest alleles is <0.33 of the largest allele, then report the largest allele as the major contributor and the remaining alleles as the minor contributor. If this condition isn't met, the locus is reported as indistinguishable.

Loci with Two Alleles

Heterozygous Major

If the peak height ratio of the alleles is ≥ 0.65 , then report the two alleles as the major contributor. No minor contributor will be reported at this locus.

Homozygous Major

If the peak height ratio of the alleles is ≤ 0.14 , then report the highest peak as the major contributor and the lowest peak as the minor contributor. The sister allele of the minor contributor shall be designated as either an "A" or an "M". If the peak height ratio of the two peaks is >0.14 and <0.65 , the locus is reported as indistinguishable.

Loci with One Allele

Evaluate the profile overall and determine that there are no conditions that exist which may result in allelic drop-out at this locus. If allelic drop-out of the major profile is not suspected, then the allele is reported as the major contributor. No minor contributor will be reported at this locus.

Statistical Analysis

A single source Random Match Probability (RMP) statistical calculation shall be utilized for the major and minor contributors for a distinguishable two person mixture. (See [Appendix 4](#))

Deducing a Foreign Profile Using a Known Contributor

Interpretation

When a contributor to an assumed two person mixture is known, the known profile may be used to determine the genotype of the foreign profile. This method can be employed on samples that are either intimate or that are corresponding fractions of a differential extraction. In intimate samples, the known profile will be the standard of the person from whom the sample was collected. In differential extractions, the known profile will be the single source or single source major profile developed in the corresponding fraction of the same differential extraction.

If a known/assumed contributor is present and a foreign profile is being deduced, genotype pairings for the mixture ratio calculations shall be done by hand using the assumed genotype. All three and four

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

allele loci (without indication of possible allelic dropout) in which the unknown profile is unambiguously observed (two independent foreign alleles present) shall be used to calculate the average mixture ratio. When a mixture approaches a 1:1 ratio, the known contributor may flip from the major contributor to the minor contributor. The individual locus mixture ratios should be calculated maintaining the same contributor in the numerator of the ratio at every locus. This may mean that the locus mixture ratio will drop below 1.0 at some loci. If some loci have a mixture ratio below 1.0, the average mixture ratio shall not be calculated for the profile. The individual locus mixture ratios should be evaluated to aid in an expected mixture ratio range for deduced profile genotype determinations.

The calculated average mixture ratio and peak height ratios should be used in the evaluation of the mixture. A peak height ratio of <0.65 between the known contributor peaks may be an indication that allele sharing may be occurring.

If there is ambiguity in the genotype of the foreign profile, the following nomenclature shall be used:

M (i.e. 9, M): Use when one obligate foreign allele is known but the sister allele may be masked. When comparing the profile, the standard shall contain a genotype consisting of the alleles present at the locus and at least one of them shall be the obligate allele. If a standard has the obligate allele, but the sister allele is not present in the mixture, the standard shall be excluded as a contributor.

A (i.e. 9, A): Use when one obligate foreign allele is known but the sister allele may be any other allele at the locus. The corresponding allele may be either dropped-out or masked. When a single obligate foreign allele is \leq the established stochastic threshold, the "A" designation shall be used for the sister allele. When comparing the profile, the standard shall contain the obligate allele, but any other allele may be present. If a standard does not have the obligate allele, the standard shall be excluded as a contributor.

Statistical Analysis

A Random Match Probability (RMP) shall be used for the deduced profile (see [Appendix 4](#)). No statistical calculations shall be performed on the known contributor's profile.

Indistinguishable Mixture

Interpretation

An assumed two person mixture shall be considered indistinguishable if it doesn't meet the guidelines for pulling a major profile or deducing a foreign profile.

The interpretation of an indistinguishable assumed two person mixture requires the selection of possible contributor genotype combinations. The selected genotype combinations shall be documented in the case record for statistical analysis and drawing conclusions. The following information may be utilized by the analyst to determine appropriate genotype combinations:

1. Peak Height Ratios
 - $\text{PHR} \geq 0.65$ may indicate allele pairs.
 - $\text{PHR} < 0.65$ may indicate alleles that do not pair OR allele sharing may be occurring.
 - Shared allele $\text{PHR} \geq 0.65$ may indicate shared allele pairs.
2. Genotype Mixture Ratios
 - Mixture Ratios for appropriate genotype combinations ± 1 of the average mixture ratio may indicate genotype combinations for consideration.
3. Possible peaks in stutter position

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- Possible peaks in stutter position shall be considered in the assessment of genotype combinations and addressed in statistical analysis by using the ambiguous zygosity formula.
- 4. Drop-out of sister allele
 - Possible genotype combinations demonstrating potential for drop-out of one sister allele shall be indicated with an A (i.e. 9,A).
- 5. Drop-out of complete genotype
 - Loci demonstrating the potential for loss of an entire genotype shall not be assessed for possible genotype combinations or used in statistical analysis.

Two Person Mixture Genotype Combinations (Modified from Clayton et. al., 1998)							
One Allele (A)		Two Alleles (A,B)		Three Alleles (A,B,C)		Four alleles (A,B,C,D)	
A,A	A,A	A,A	A,B	A,A	B,C	A,B	C,D
A,A	A,X	A,B	A,B	B,B	A,C	A,C	B,D
A,X	A,X	A,A	B,B	C,C	A,B	A,D	B,C
A,A	*	A,B	B,B	A,B	A,C		
A,X	*	A,X	B,B	B,C	A,C		
		A,X	A,B	A,B	B,C		
		B,X	A,A	A,X	B,C		
		B,X	A,B	B,X	A,C		
		A,X	B,X	C,X	A,B		
		A,B	*				

X = drop-out of sister allele

* = drop-out of entire genotype

Statistical Analysis

A Modified Random Match Probability (mRMP) statistical calculation shall be utilized for indistinguishable two person mixtures (see [Appendix 4](#)).

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS APPENDIX 3 ASSUMED THREE PERSON MIXTURE INTERPRETATION

Introduction

An assumed three person mixed DNA profile can be classified as an indistinguishable mixture, a mixture demonstrating two major contributors, or a mixture demonstrating a single major contributor.

Indistinguishable Mixture

Interpretation

An assumed three person mixture shall be considered indistinguishable if it doesn't meet the guidelines for pulling a major profile detailed below.

Statistical Analysis

A Combined Probability of Inclusion (CPI) statistical calculation shall be utilized for indistinguishable three person mixtures (see [Appendix 4](#)). A CPI calculation shall only be used with Technical Leader approval documented in the case record. If no loci are eligible for a statistical calculation, no conclusions will be made regarding the DNA result.

Two Person Mixed Major Profile

Interpretation

A two person mixed major profile shall only be determined with Technical Leader approval documented in the case record. No conclusion shall be drawn regarding the minor profile.

Statistical Analysis

The two person mixed major profile statistic shall be calculated using the modified Random Match Probability (mRMP) statistical calculation (see [Appendix 4](#)). No conclusion or statistic will be applied to the minor profile.

Single Source Major Profile

Interpretation

The following methodology was created to aid in the determination a single source major profile. The following criteria do not apply to Amelogenin. The formulas are intended to be conservative, thus minimizing the possibility of selecting a false major. The DNA analyst will still need to use caution and only attempt to interpret samples demonstrating good quality data. **The IndySTR excel program has an additional tab to account for the possible impact of stutter. On this tab, the program subtracts the validated mean stutter value (per locus) from every called peak where a sister peak four bases higher is greater than or equal to 900 RFU. The adjusted peak heights are then used in the calculations to pull a single major profile.**

Criteria for pulling a single major profile at a locus are as follows:

1. Mixture ratio $\geq 3:1$ (using formulas listed below)
2. Peak Height Ratio (PHR) for heterozygous major genotype (using formulas listed below)
 - ≥ 0.65 for loci demonstrating 2, 5 or 6 alleles
 - ≥ 0.50 for loci demonstrating 3-4 alleles

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

3. Minimum RFU values for major profile when no independent minor profile alleles are present
 - Heterozygous major peaks at a locus with two alleles shall be greater than or equal to two times the stochastic threshold (ST)
 - A homozygous major peak at a locus with one allele shall be greater than or equal to three times the stochastic threshold (ST)
4. A minimum of 6 loci are necessary to pull a single source major profile; fewer than 6 loci will require approval of the Technical Leader. No conclusions will be drawn from the minor profile.

Formulas for Calculating the Mixture Ratio and Heterozygous Peak Height Ratio

Alleles are designated A-F in descending RFU value with A and B reserved for the major alleles. Alleles C-F will designate alleles of the minor contributors. Peaks designated as possible alleles in stutter position will not be considered.

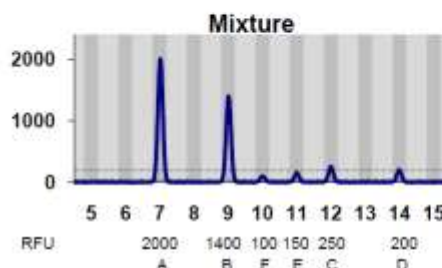
Heterozygous Major formulas

1. When 6 alleles are present at a locus

- a. Mixture ratio = $\frac{(A+B)}{(C+D+E+F)}$
- b. PHR = $\frac{B}{A}$ (PHR shall be ≥ 0.65)
- c. Example

$$MR = \frac{(2000+1400)}{(250+200+150+100)} = 4.85$$

$$PHR = \frac{1400}{2000} = 0.70 \text{ (major pulled)}$$

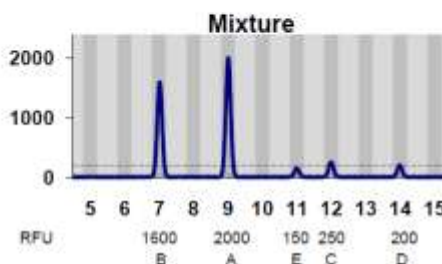


2. When 5 alleles are present at a locus

- a. Mixture ratio = $\frac{(A+B-C)}{(2C+D+E)}$
- b. PHR = $\frac{(B-C)}{A}$ (PHR shall be ≥ 0.65)
- c. Example

$$MR = \frac{(2000+1600-250)}{[2(250)+200+150]} = 3.94$$

$$PHR = \frac{(1600-250)}{2000} = 0.68 \text{ (major pulled)}$$

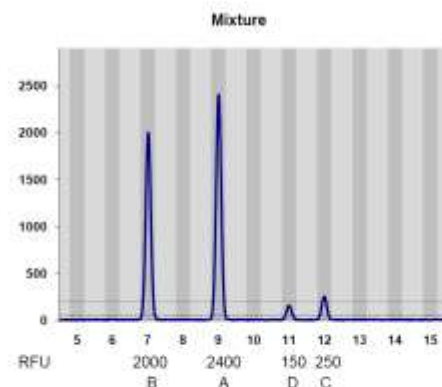


3. When 4 alleles are present at a locus

- a. Mixture ratio = $\frac{(A+B-2C)}{(3C+D)}$
- b. PHR = $\frac{(B-2C)}{A}$ (PHR shall be ≥ 0.50)
- c. Example

$$MR = \frac{[2400+2000-2(250)]}{[3(250)+150]} = 4.33$$

$$PHR = \frac{[2000-2(250)]}{2400} = 0.63 \text{ (major pulled)}$$



INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

4. When 3 alleles are present at a locus

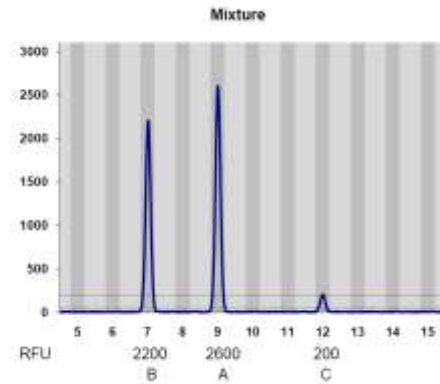
a. Mixture ratio = $\frac{(A+B-3C)}{4C}$

b. $PHR = \frac{(B-3C)}{A}$ (PHR shall be ≥ 0.50)

c. Example

$$MR = \frac{[2600+2200-3(200)]}{4(200)} = 5.25$$

$$PHR = \frac{[2200-3(200)]}{2600} = 0.62 \text{ (major pulled)}$$



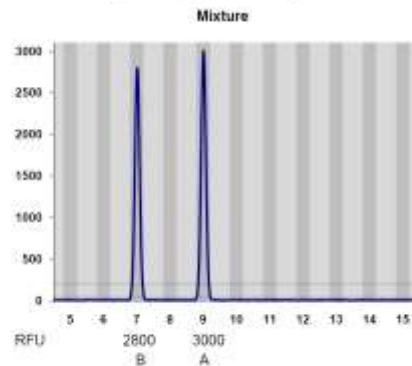
5. When 2 alleles are present at a locus

a. Both allele peaks shall be $\geq 2X$ ST

b. $PHR = \frac{B}{A}$ (PHR shall be ≥ 0.65)

c. Example

$$PHR = \frac{2800}{3000} = 0.93 \text{ (major pulled)}$$



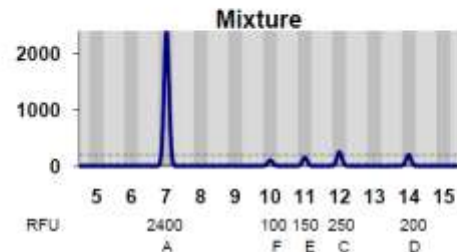
Homozygous Major formulas

1. When 5 alleles are present at a locus

a. Mixture ratio = $\frac{A}{(C+D+E+F)}$

b. Example

$$MR = \frac{2400}{(250+200+150+100)} = 3.42 \text{ (major pulled)}$$

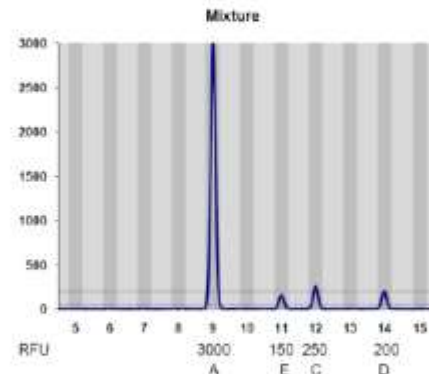


2. When 4 alleles are present at a locus

a. Mixture ratio = $\frac{(A-C)}{(2C+D+E)}$

b. Example

$$MR = \frac{(3000-250)}{[2(250)+200+150]} = 3.23 \text{ (major pulled)}$$



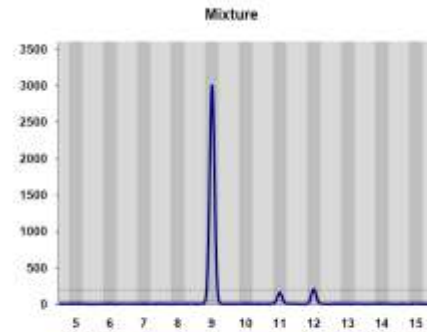
INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

3. When 3 alleles are present at a locus

a. Mixture ratio formula = $\frac{(A-2C)}{(3C+D)}$

- b. Example

$$MR = \frac{[3000-2(200)]}{[3(200)+150]} = 3.46 \text{ (major pulled)}$$

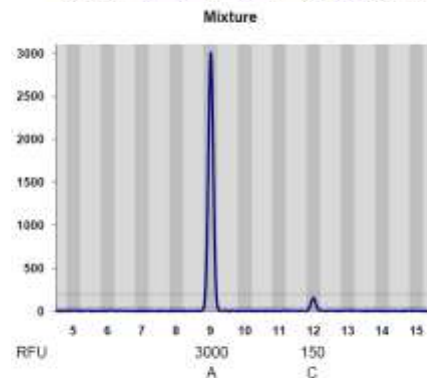


4. When 2 alleles are present at a locus

a. Mixture ratio formula = $\frac{(A-3C)}{4C}$

- b. Example

$$MR = \frac{[3000-3(150)]}{4(150)} = 4.25 \text{ (major pulled)}$$



5. When 1 allele is present at a locus

If the allele is $\geq 3X$ ST, it shall be up to the analyst's discretion to determine if the major profile is fully represented at the locus. If the analyst determines that there is no possible dropout of a major allele, the locus may be included in the major profile.

Statistical Analysis

The single source major profile statistic shall be calculated using the Random Match Probability (RMP) statistic (see [Appendix 4](#)). No conclusion or statistic will be applied to the minor profile.

**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS
APPENDIX 4**

Statistical Analysis for Autosomal DNA Testing

Introduction

When an inclusion is made during the interpretation and comparison of a meaningful evidence profile, the statistical relevance or weight of the profile shall be calculated.

Application

Examples of profiles that do not need statistics calculated would include single source profiles of unknown individuals or the profile of the owner on intimate samples.

If no loci are eligible for a statistical calculation, then no conclusions shall be drawn from that sample and it shall be reported accordingly.

Statistics may be calculated using IndySTR or by hand calculation. Statistics calculated by IndySTR shall automatically be rounded to the appropriate number of significant figures.

The loci and/or genotype combinations of the evidence profile determined to be suitable for statistical calculation shall be indicated on the appropriate worksheet and/or IndySTR excel program before comparison to associated standards.

Random Match Probability

The Random Match Probability (RMP) is an estimate of the probability of selecting an unrelated individual at random that would match the evidence DNA profile.

Application

RMP applies to single source DNA profiles, including deduced profiles and deconvoluted major/minor profiles.

Each locus genotype frequency shall be calculated using the appropriate formula listed in Table 1. The product rule shall be used to estimate the profile frequency.

A locus demonstrating an allele with ambiguous zygosity, such as one allele detected below stochastic threshold (i.e. [9],A) or a minor genotype with a possible masked allele (i.e. 9,M) shall use the ambiguous zygosity formula, also known as the “2p rule” or “allele, any”. This formula considers that the obligate allele may pair with any other detected or undetected allele at the locus.

Modified Random Match Probability

The Modified Random Match Probability (modified RMP or mRMP) is an estimate of the probability of selecting an unrelated individual at random that would be included as a potential contributor to the two person mixed profile.

Application

Modified RMP applies to assumed two person mixture profiles with indistinguishable components.

Each locus genotype frequency shall be calculated using the appropriate formula listed in Table 1. A locus demonstrating more than one genotype possibility shall result in a summed frequency. The product rule shall be used to estimate the profile frequency.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

A locus demonstrating an allele with ambiguous zygosity, such as a genotype combination including A (i.e. 9,A), shall use the ambiguous zygosity formula.

Combined Probability of Inclusion/Exclusion

The Combined Probability of Inclusion (CPI), also known as Random Man Not Excluded (RMNE), is an estimate of the probability of selecting an unrelated individual in the population that would be included as a potential contributor to the mixed sample. The Combined Probability of Exclusion (CPE) is an estimate of the probability of selecting an unrelated individual in the population that would be excluded as a contributor to the mixed sample. CPE is the complement of CPI. A CPI calculation shall only be used with Technical Leader approval documented in the case record.

Application

CPI applies to indistinguishable three person mixtures and mixtures in which the number of contributors cannot be reasonably assumed.

CPI calculations make no assumption regarding the number of contributors, thereby allowing for all genotype combinations to be considered.

All alleles present shall be included in the calculation for each locus determined suitable for statistical calculation.

All possible peaks in stutter position that cannot be confidently eliminated as stutter peaks shall be included in the calculation.

All alleles at a locus shall be above the established stochastic threshold for the locus to be used in the calculation.

Any loci demonstrating possible allelic drop-out shall not be included in the calculation. Possible allelic drop-out may be demonstrated by called alleles below the stochastic threshold or by peaks visible below the 50 RFU analytical threshold. Analyst discretion is allowed to not mark a locus for statistical calculation based on potential for drop-out due to a general low quality/low RFU profile.

The frequency of each allele detected at a locus shall be summed for use in the formulas listed in Table 2. The product rule shall be used to estimate the profile frequency.

Formulas

Table 1: Formulas for RMP and modified RMP

Heterozygous genotype	Homozygous genotype	Ambiguous zygosity
$2pq$	$p^2 + p(1-p)\theta$	$p^2 + p(1-p)\theta + 2p(1-p)$

p =frequency of 1st allele; q = frequency of 2nd allele

Table 2: Formulas for CPI/CPE

Sum of allele frequencies	Locus frequency	Profile frequency
$p = (p_1 + p_2 + p_3 + \dots)$	$PI = p^2 + p(1-p)\theta$	$CPI = (PI_{locus1})(PI_{locus2}) \dots$
	$PE = 1 - PI$ $= 1 - [p^2 + p(1-p)\theta]$	$CPE = 1 - CPI$ $= 1 - [(1 - PE_{locus1})(1 - PE_{locus2}) \dots]$

p_1 =frequency of 1st allele; p_2 =frequency of 2nd allele; p_3 =frequency of 3rd allele

Theta (θ)

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Theta (θ) correction is a value to adjust for population substructure in homozygous loci. Theta shall be set at 0.01 for typical populations. An adjusted value of 0.03 may be utilized with Technical Leader approval for smaller isolated populations (i.e. Native American and Amish).

Minimum allele frequency

A conservative frequency correction for alleles observed less than 5 times in the STR population frequency tables.

Formula: $5/2N$; where N = the number of individuals tested for the population frequency study.

STR Population Frequencies

Budowle B., Moretti T.R., Baumstark A.L., Defenbaugh D.A., Keys K.M. Population data on the thirteen CODIS core short tandem repeat loci in African Americans, U.S. Caucasians, Hispanics, Bahamians, Jamaicans, and Trinidadians. J. Forensic Sci. 1999; 44(6): 1277-1286.

Moretti, T.R., Budowle, B. and Buckleton, J. S. Erratum. J. Forensic Sci. 2015; 60(4).

Budowle B., Shea B., Niezgoda S., Chakraborty R. CODIS STR Loci Data from 41 Sample Populations. J. Forensic Sci. 2001; 48(3): 453-489

Levandakou E. N., et al. Allele Frequencies for Fourteen STR Loci of the PowerPlex™ 1.1 and 2.1 Multiplex Systems and Penta D Locus in Caucasians, African-Americans, Hispanics, and Other Populations of the United States of America and Brazil. J. Forensic Sci. 2001; 48(3): 736-761.

References

Smith J., Budowle B. Source Identification of Body Fluid Stains Using DNA Profiling. Proceedings of the Second European Symposium, Innsbruck, Austria. 6/98

Budowle B., Chakraborty R., Carmody G., Monson K. Source Attribution of a Forensic DNA Profile. *Forensic Science Communications*. July 2000, Volume 24, Number 3.

Bille T., Bright J., Buckleton J. Application of Random Match Probability Calculations to Mixed STR Profiles. J. Forensic Sci. 2013; 58(2): 474-481.

National Research Council, Committee on DNA Forensic Science: An Update. The Evaluation of Forensic DNA Evidence. National Academy Press, Washington D.C., 1996.

Scientific Working Group on DNA Analysis Methods. SWGDAM Interpretation Guidelines for Autosomal STR Typing by Forensic DNA Testing Laboratories. 2010. Available at <http://www.fbi.gov/about-us/lab/codis/swgdam.pdf>.

**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS
APPENDIX 5 REPORT WORDING**

These are general wording guidelines for commonly occurring test results. Alterations must be approved by a supervisor. Any words in these guidelines that are in *italics* should be changed to reflect your results. Words or phrases in [] are optional.

WHEN MULTIPLE CONTENTS ARE IN AN ITEM AND NOT ACCOUNTED FOR IN THE BOLDED ITEM OR SUBITEM DESCRIPTION:

Item X **Item Description:** # of item description [item X] was/were present.

NEGATIVE RESULTS:

Item X **Item Description:** No blood/seminal material/amylase was detected. Item description will be returned to the submitting agency.

POSITIVE RESULTS:

Item X **Item Description:** Blood/ Seminal material/Amylase was detected. Samples were retained as item XA. Item description will be returned to the submitting agency.

PRESUMPTIVE TESTING POSITIVE AND CONFIRMATORY TESTING NEGATIVE:

Item X **Item Description:** Serological testing indicated the possible presence of blood/seminal material. Additional serological testing did not confirm the presence of blood/seminal material. X samples were retained in item XA. Item description will be returned to the submitting agency.

PRESUMPTIVE TESTING POSITIVE AND SAMPLE SIZE LIMITED:

Item X **Item Description:** Serological testing indicated the possible presence of blood/seminal material. Additional serological testing for blood/seminal material was not performed in order to preserve the sample for DNA analysis. X samples were retained in item XA. Item description will be returned to the submitting agency.

PRESUMPTIVE TESTING POSITIVE AND NO PROBATIVE VALUE:

Item X **Item Description:** Serological testing indicated the possible presence of blood/seminal material. No further serological testing was performed at this time. [If further analysis is desired, please contact

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

the reporting analyst.] *Item description* will be returned to the submitting agency.

SPECIES ORIGIN TESTING:

Human Origin:

Item X ***Item Description:*** Human blood was detected. A sample was retained as item *XA*. *Item description* will be returned to the submitting agency.

Item X ***Item Description:*** Blood, not of human origin, was detected. *Item description* will be returned to the submitting agency.

Other Species:

Item X ***Item Description:*** *Blood of other species* origin was detected. *Item description* will be returned to the submitting agency.

Item X ***Item Description:*** Blood was detected; however, species origin could not be determined. *Item description* will be returned to the submitting agency.

Item X ***Item Description:*** Serological testing indicated the possible presence of blood. Additional serological testing did not confirm the presence of blood; however, proteins of *other species* origin were detected. *X* samples were retained in item *XA*. *Item description* will be returned to the submitting agency.

NO TESTING PERFORMED:

Item X ***Item Description:*** No stains were observed for serological testing. [A sample was retained as item *XA*.] *Item description* will be returned to the submitting agency.

Item X ***Item Description:*** No serological testing was performed. [A sample was retained as item *XA*.] *Item description* will be returned to the submitting agency.

TRACE EVIDENCE:

Within the item:

Item X ***Item Description:*** Potential trace evidence was *observed/collected*.

At the end of the report:

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

Trace evidence [*observed on/collected from item(s) X*] may include but is not limited to paint, glass, hair, and fibers. To determine if further examination is warranted, please contact the reporting analyst.

HAIR STATEMENTS:

Pubic hair combings, pubic hair standards and head hair standards may be reported out as “Hair was present” or by use of the Trace statement.

Item X ***Item Description:*** Hair demonstrating characteristics consistent with human hair and having root material with the potential for nuclear DNA analysis was *observed/collected*. [Hair was retained as item XA.]

Human hair without roots, or other hairs may be considered trace evidence when not significant. The wording below is to be used when of evidentiary value.

Item X ***Item Description:*** Hair demonstrating characteristics consistent with human hair but not having root material with the potential for nuclear DNA analysis was *observed /collected*. To determine if further analysis is beneficial, please contact the reporting analyst.

Item X ***Item Description:*** Hair demonstrating characteristics not consistent with human hair was observed.

STANDARDS:

Item X **Blood Standard – John Smith:** A stain card was prepared and retained as XA. The blood standard was returned to *item X/the submitting agency*.

Item X ***Buccal swab/hair/other – John Smith:*** [Two] Swabs were [present and] retained as XA. The original packaging will be returned to the submitting agency.

Item X The *oral swab standard/red topped whole blood standard* present was not *retained/examined* due to the presence of multiple standards.

At the end of the report:

If additional information is desired, please submit an appropriate DNA standard (such as a blood standard in a purple top tube or an oral swab standard) from *victim* and/or any *suspect(s)*.

SEROLOGY REPORT STATEMENT FOR SEPARATE DNA EXAMINATION:

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

When completed, results of any DNA analysis will be provided separately. All qualifying DNA profiles will be entered into the Indiana DNA database and searched on a routine basis.

SINGLE SOURCE STATEMENTS:

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] *is/is not* consistent with *John Doe* (item XA) [and is estimated to occur once in # unrelated individuals].

Detection of One Additional Allele:

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] *is/is not* consistent with *John Doe* (item XA) [and is estimated to occur once in # unrelated individuals]. However, one additional allele was detected from which no conclusion can be drawn.

MIXTURE STATEMENTS:

Indistinguishable Mixture (mRMP Calculated):

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] is consistent with a mixture of two individuals. *John Doe* (item XA) and *Jane Doe* (item XA) *can/cannot* be excluded as possible contributors. [It is estimated that one in # unrelated individuals could contribute to this mixture.]

Indistinguishable Mixture (CPI calculated):

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] is consistent with a mixture of at least *two/three* individuals. *John Doe* (item XA) and *Jane Doe* (item XA) *can/cannot* be excluded as possible contributors. [It is estimated that one in # unrelated individuals could contribute to this mixture.]

Distinguishable Major/Minor Profile In A Two Person Mixture:

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] is consistent with a mixture of two individuals. A major profile was determined at # loci that *is/is not* consistent with *John Doe* (item XA) [and is estimated to occur once in # unrelated individuals]. A minor profile was determined at # loci. Assuming the minor DNA result originated from a single individual, the alleles detected *are/are not* consistent with *Jane Doe* (item XA) [and are estimated to occur once in # unrelated individuals].

Distinguishable Major Profile In a Three Person Mixture or Where Number of Contributors Cannot Be Assumed:

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] is consistent with a mixture of at least *two/three* individuals. A

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

major profile was determined at # loci that *is/is not* consistent with *John Doe* (item XA) [and is estimated to occur once in # unrelated individuals]. Due to the uncertainty in the number of contributors, no conclusions were drawn from the minor profile.

Distinguishable Mixed Major Profile:

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] is consistent with a mixture of at least three individuals. An assumed major DNA profile of two individuals was determined at # loci from which *John Doe* (item XA) and *Jane Doe* (item XA) *can/cannot* be excluded as possible contributors. [It is estimated that one in # unrelated individuals could contribute to the observed mixed major profile.] Due to the uncertainty in the number of contributors, no conclusions were drawn from the minor profile.

Deduced Profile Determined From An Intimate Sample:

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] is consistent with a mixture of two individuals. Assuming *Jane Doe* (item XA) as a contributor, a deduced profile was determined at # loci that *is/is not* consistent with *John Doe* (item XA) [and is estimated to occur once in # unrelated individuals].

Deduced Profile Determined From A Differential Extraction:

Item XA The DNA *profile/result obtained/developed* from the *non-sperm/sperm* [cell] fraction [of *item description* item XA] is consistent with a mixture of two individuals. Assuming the [major] profile *developed/determined* from the corresponding *sperm/non-sperm* [cell] fraction as a contributor, a deduced profile was determined at # loci that *is/is not* consistent with *John Doe* (item XA) [and is estimated to occur once in # unrelated individuals].

Single Source Intimate Sample With No Foreign Alleles Detected:

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] is consistent with *Jane Doe* (item XA). Assuming *Jane Doe* as a contributor, no additional alleles were detected.

Intimate Sample With No Conclusion Being Drawn From Additional Alleles:

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] is consistent with a mixture of at least *two/three* individuals. Assuming *Jane Doe* (item XA) as a contributor, no further conclusions could be drawn due to the uncertainty in the number of contributors.

Differential Sample With No Conclusion Being Drawn From Additional Alleles:

Item XA The DNA *profile/result obtained/developed* from the *non-sperm/sperm* [cell] fraction [of *item description* item XA] is consistent with a mixture of at least *two/three* individuals. Assuming the [major] profile

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

developed/determined from the corresponding *sperm/non-sperm* [cell] fraction as a contributor, no further conclusions could be drawn due to the uncertainty in the number of contributors.

Non-Sperm/Sperm Fraction Of An Intimate Differential Sample Where Result Is Consistent With Assumed Profiles Only:

Item XA The DNA *profile/result obtained/developed* from the *non-sperm/sperm* [cell] fraction [of *item description* item XA] is consistent with a mixture of two individuals. Assuming *Jane Doe* (item XA) and the [major] profile *developed/determined* from the *sperm/non-sperm* [cell] fraction as contributors, no additional alleles were detected.

SAMPLES UNSUITABLE FOR COMPARISON:

No Alleles Detected:

Item XA [Item description] Failed to demonstrate a DNA profile.

Inconclusive Due To Inability To Assume A Specific Number of Contributors:

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] demonstrated a *partial DNA profile/the presence of a mixture* in which the number of contributors cannot reasonably be assumed. Therefore, no further conclusions were drawn.

Inconclusive Due To Inability To Perform A Statistical Calculation:

Item XA The DNA *profile/result obtained/developed* [from *item description* item XA] demonstrated the presence of a mixture of at least # individuals. The results do not qualify for statistical calculations; therefore, no further conclusions were drawn.

Inconclusive Due To A Failed Control:

Item XA No conclusion can be drawn [on *item description* item XA] because *the/a* test control(s) did not meet required parameters.

If Multiple Samples Are Being Reported Out As Inconclusive Due To A Failed Control:

Within the item

Item XA No conclusion can be drawn regarding [*item description*] item XA.

At end of report

No conclusion could be drawn regarding items X, Y and Z because *the/a* test control(s) did not meet required parameters.

SAMPLES NOT AMPLIFIED:

Insufficient Human DNA:

Item XA *Item description* [item XA] failed to demonstrate a sufficient quantity of DNA for further analysis.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Insufficient Male DNA:

Item XA *Item description* [item XA] failed to demonstrate a sufficient quantity of male DNA for autosomal STR analysis.

Standards:

When The Required Statement Listing Loci Analyzed Was Used:

Item XA The DNA standard of/from *item description* [item XA] was extracted and quantified; however, no additional DNA analysis was performed due to a lack of evidence for comparison.

When No Amplification Statement Was Used:

Item XA No profile was developed from the DNA standard of/from *item description* [item XA] due to a lack of evidence for comparison.

STANDARD DEVELOPED FOR COMPARISON:

Item XA The DNA *profile/result obtained/developed of/from item description* [item XA] *was/will be used/developed* for comparison purposes.

When Standards from another case have been used for comparison but are not mentioned with any developed profiles, the following paragraph should be placed at the end of the report.

The DNA profiles developed were compared to the DNA profile of *John Doe* (item XXA, Indiana State Police Laboratory Case XXX-XXXXX, Other Police Department Case XXXXX).

The DNA profile of *John Doe* (item XXA) was compared to the evidence in Indiana State Police Laboratory Case XXX-XXXXX, Other Police Department Case XXXXX.

SAMPLE/SUBITEM NOT EXAMINED:

Item XA No DNA analysis was performed on *item description* [item XA] at this time.

Item XA Due to limited sample size, no DNA analysis was performed on *item description* [item XA] at this time.

Item XA No DNA analysis was performed on *item description* [item XA] at this time. If further DNA analysis is desired, permission to consume the sample is required. Please contact the reporting analyst.

CONFIRMATION OF SPERMATOZOA DURING DIFFERENTIAL EXTRACTION:

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

Item XA The presence of *semen/semenal material* was confirmed during DNA testing of the the sperm [cell] fraction.

IDENTIFICATION OF CONTAMINATION FROM LABORATORY PERSONNEL (WHEN STATISTIC RARER THAN 1 IN 1,000 FOR AT LEAST ONE POPULATION GROUP). Not all possible combinations are given, consultation with the Technical Leader and/or Supervisor is recommended:

Item XA No DNA profile of apparent value was identified on *item description* [item XA]. The DNA profile of a *laboratory analyst/non-laboratory person* was identified.

Item XA The DNA *profile/result obtained/developed* from *item description* [item XA] is consistent with a mixture of two individuals. A major profile was determined at # loci that *is/is not* consistent with *John Doe* (item XA) [and is estimated to occur once in # unrelated individuals]. A minor profile was determined at # loci. Assuming the minor DNA result originated from a single individual, the alleles detected are consistent with the DNA profile of a *laboratory analyst/non-laboratory person*.

IDENTIFICATION OF IDENTICAL TWINS:

The DNA profiles obtained from *Jane Doe* (item XA) and *Susan Doe* (item XA) demonstrated the same allelic profile. This is typically associated with identical twins. The conclusions reflect the comparisons with the provided standards.

Representative Results Paragraph: Not all possible combinations are given, consultation with the Technical Leader and/or Supervisor is recommended.

Item XA The DNA profile *obtained/developed* [from *item description* item XA] is consistent with the DNA profiles of *Jane Doe* (item XA) and *Susan Doe* (item XA). Because identical twins are genetically identical, *Jane Doe* or *Susan Doe* could be the source of this DNA.

CODIS STATEMENTS:

Profile Entered (within the item):

[A portion of] The DNA profile *obtained/developed* from *item description* [item XA] *was/were* entered into the Indiana DNA Database and will be searched on a routine basis. In the event of a database match, information regarding the match(es) will be provided separately.

Pending Standard Submission:

Upon submission of an appropriate DNA standard from *Victim*, the DNA profile *obtained/developed* from [item description] item XA will be re-evaluated for possible entry into the Indiana DNA Database.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Pending Additional Information:

Additional information is required regarding *Item Description* before it can be determined if any profiles are eligible to be searched in the Indiana DNA Database. Please contact the reporting analyst if a database search is desired.

WORDING WHEN RE-EVALUATING DATA PREVIOUSLY REPORTED OUT WITH NEW FBI ALLELE FREQUENCIES

The statistical calculations were adjusted to reflect the amended allele frequencies published by the FBI. *Moretti, T.R., Budowle, B. and Buckleton, J. S., Erratum, Journal of Forensic Sciences 2015; 60(4).*

WORDING WHEN RE-EVALUATING DATA PREVIOUSLY REPORTED OUT WITH NEW INTERPRETATION GUIDELINES Requires Supervisor's Approval and Shall be Placed at the Beginning of the Results Section:

In the DNA analysis detailed below, sample data was re-evaluated using statistical methods implemented after the original report was issued. Accordingly, the following conclusions may differ from the original report.

STATEMENTS LOCATED AT THE END OF THE REPORT:

REQUIRED STATEMENTS (one or the other must be at the end of the report):

DNA Profiles Generated Using PowerPlex® 16 HS (any additional loci analyzed shall also be listed):

In the DNA analysis detailed above, Amelogenin and the following STR loci were analyzed using Polymerase Chain Reaction (PCR): D3S1358, TH01, D21S11, D18S51, Penta E, D5S818, D13S317, D7S820, D16S539, CSF1PO, Penta D, vWA, D8S1179, TPOX, and FGA.

No Samples Amplified:

Extraction and quantification were performed in the DNA analysis of the sample(s) detailed above.

REQUESTS FOR STANDARDS:

Standard For Comparison:

[Additional] Comparisons will be made upon submission of an appropriate DNA standard (such as a blood standard in a purple top tube or an oral swab standard) from *victim* and/or any suspect(s).

Standard For Y-STR Analysis:

Upon submission of an appropriate DNA standard (such as a blood standard in a purple top tube or an oral swab standard) from any suspects, this case *may/will be* evaluated for Y-STR analysis.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

SAMPLES FORWARDED FOR ADDITIONAL ANALYSIS:

Y-STR Evaluation Pending:

This case will be evaluated for possible Y-STR analysis. Any results from additional testing will be provided separately.

Criminal Paternity/Kinship Analysis Pending:

When completed, *Paternity/Kinship* analysis of the DNA profiles determined for *John Doe* (item *XA*), *Jane Doe* (item *XA*), and *Baby Doe* (item *XA*) will be provided separately.

CODIS STATEMENT WHEN PROFILES ARE DEVELOPED BUT NONE ARE SUITABLE FOR ENTRY:

No DNA profiles were *suitable/eligible* for entry into the Indiana DNA Database.

WORDING OF STATISTICAL ANALYSIS:

When A Calculation With A Frequency Is Reported The Following Paragraph Shall Be Added:

Note: Statistical estimates were performed based on the recommended concepts endorsed by the Scientific Working Group on DNA Analysis Methods (1/14/10). Calculations for the Caucasian, African American, and Hispanic populations have been performed. The most common frequency has been reported unless all calculated frequencies exceed 1 in 8 trillion.

EVIDENCE DISPOSITION STATEMENT:

All retained items will remain at the Indiana State Police Laboratory for the possibility of future analysis.

WITHDRAWAL STATEMENT:

The request for *analysis/DNA analysis* was withdrawn by *John Smith, Police Department*, on *Date*. The submitted items will be returned to *Police Department*.

EXAMPLES

Opening paragraph for an evidence kit (similar formatting will be used for an item containing multiple items).

Item 001 **Evidence Collection Kit – Victim:** Items 001A through 001Z were present in or prepared from items in the kit. The kit will be returned to the submitting agency.

Each subitem in a kit will have a disposition after serology results. See examples below:

Item 001A Blood standard: A stain card was prepared and retained as item 001A1. The blood tube was returned to item 001.

INDIANA STATE POLICE

FORENSIC BIOLOGY SECTION

TEST METHODS

- Item 001A1 Stain card standard for Jane Doe: The DNA profile developed was used for comparison purposes.
- Item 001B Vaginal wash: No seminal material was detected. The vaginal wash tube was returned to item 001.
- Item 001C Vaginal/cervical swabs: Two swabs, items 001C1 and 001C2, were present. Serological testing indicated the possible presence of seminal material and blood. Additional serological testing did not confirm the presence of seminal material. Confirmatory testing for blood was not performed at this time. The swabs were retained.

The DNA profile obtained from the combined swabs is consistent with Jane Doe (item 1A1) and is estimated to occur once in # unrelated individuals.

Each item and subitem will have testing results reported. See examples below:

- Item 002 Duct tape:** Two pieces of duct tape were present. No serological testing was performed; however, four samples were made and retained as item 002A. The duct tape will be returned to the submitting agency.
- Item 002A The DNA result obtained from the swab (item 002A2) is consistent with an unknown male. This profile was entered into the Indiana DNA Database and will be searched on a routine basis. In the event of a database match, information regarding the match(es) will be provided separately.
- The combined swabs (items 002A1 and 002A3) failed to demonstrate a sufficient quantity of DNA for further analysis.
No DNA analysis was performed on the swab (item 002A4) at this time.

May put each result into a separate paragraph as below:

- Item 005 Wipes:** Three wipes were present and labeled 005A1, 005A2 and 005A3. Serological testing indicated the possible presence of blood on item 005A1. Additional serological testing did not confirm the presence of blood. Three samples were retained within item 005A. Blood was detected on items 005A2 and 005A3. Four samples were retained within item 005A. The wipes will be returned to the submitting agency.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Item 005A	<p>The DNA profile obtained from item 005A1a is consistent with John Smith (item 007A) and is estimated to occur once in more than 8 trillion unrelated individuals.</p> <p>The DNA profile obtained from 005A2a is consistent with John Smith (item 007A) and is estimated to occur once in more than 8 trillion unrelated individuals. However, one additional allele was detected. No conclusions can be drawn from the additional allele.</p> <p>Items 005A1b and 005A1c failed to demonstrate a sufficient quantity of DNA for further analysis.</p> <p>No DNA analysis was performed on items 005A3a and 005A3b at this time.</p>
Item 007	Oral swabs – John Smith: Two swabs were present. The swabs were retained as item 007A. The original packaging will be returned to the submitting agency.
Item 007A	The DNA profile developed was used for comparison purposes.

Relationship Testing Wording

DNA STR Locus	Mother <i>Item 1A</i>	Child <i>Item 2A</i>	Alleged Father <i>Item 3A</i> <i>Race</i>	Paternity Index
D3S1358				
TH01				
D21S11				
D18S51				
Penta E				
D5S818				
D13S317				
D7S820				
D16S539				
CSF1PO				
Penta D				
vWA				
D8S1179				
TPOX				

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

FGA

**Combined Paternity Index =
Probability of Paternity = %**

Alternatively, the genetic results of the Amelogenin locus can also be reported in the table on the Certificate of Analysis when the gender of an individual may be meaningful.

PARENTAGE RESULTS:

A parentage case where alleged individual cannot be excluded:

John Doe (item XA), the alleged father, cannot be excluded as the biological father of *the child* (item XA). The genetic results listed below are *CPI* times more likely if *John Doe* is the biological father of *the child* than a random, untested, unrelated man in the *Caucasian/African American/Hispanic* population. The probability of paternity (assuming a prior probability of 0.5) is [W] %.

A parentage case where alleged individual can be excluded:

Given the lack of genetic markers that must be contributed to the child by the biological father in the genetic results listed below, *John Doe* (item XA), the alleged father, can be excluded as the biological father of *the child* (item XA).

A parentage case with inconclusive results:

The genetic results listed below do not strongly favor the hypothesis of *John Doe* (item XA), the alleged father, being the biological father of *the child* (item XA). The Combined Paternity Index of *CPI* is low and does not meet our laboratory standards in order to establish paternity; therefore, these results are inconclusive. The genetic results are based only on the current data and additional genetic testing is recommended.

A reverse parentage case where alleged individuals cannot be excluded:

Jane Doe (item XA), the alleged mother, and *John Doe* (item XA), the alleged father, cannot be excluded as the biological parents of *the child*. The genetic results listed below are *CPI* times more likely if *Jane Doe* and *John Doe* are the biological parents of *the child* than random, untested, unrelated individuals in the *Caucasian/African American/Hispanic* population. The probability of parentage (assuming a prior probability of 0.5) is [W] %.

SIBSHIP RESULTS:

A sibship comparison with evidence of relationship:

The genetic results listed below support the conclusion that *John Doe* (item XA) and *Joe Doe* (item XA) are related as full siblings. These genetic results are *CRI* times more likely if *John Doe* is a full sibling of *Joe Doe* than if they are unrelated. The probability of relationship (assuming a prior probability of 0.5) is [W] %.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

A sibship comparison with no evidence of relationship:

The genetic results listed below support the hypothesis that *John Doe* (item XA) and *Joe Doe* (item XA) have different biological parents over the hypothesis that *John Doe* and *Joe Doe* share biological parents. These genetic results are *CRI* times more likely if *John Doe* is unrelated to *Joe Doe* than if they are full siblings. The genetic results are based only on the current data and do not supersede any additional genetic testing.

A sibship comparison with inconclusive results:

The genetic results listed below do not strongly support the hypothesis that *John Doe* (item XA) and *Joe Doe* (item XA) share the same biological parents nor does it indicate that *John Doe* and *Joe Doe* have different biological parents; therefore, it is deemed inconclusive. The Combined Relationship Index for full siblings of *CRI*/ is low and does not meet the laboratory standards necessary to establish a relationship. The genetic results are based only on the current data and additional genetic testing is recommended. Please contact the reporting analyst in regards to further genetic testing.

CASES WITH AN OBSERVED MUTATION:

A single genetic inconsistency between the child and the alleged father was observed at *Locus*. This has been incorporated into the calculation as a mutation.

CASES WITH AN OBSERVED MIXTURE:

A mixture was observed in the sample of *John Doe* (item XA). The following loci were not suitable for statistical calculations as the obligate paternal allele was not able to be determined: (list loci).

CASES WITH MULTIPLE EVIDENTIARY OR STANDARD SAMPLES:

DNA profiles were developed for [two] additional samples of *item description* (item XA); however, these profiles were not used for statistical purposes.

WHEN A STATISTICAL CALCULATION IS BEING REPORTED:

Statistical calculations were performed based on the recommendations of the AABB (American Association of Blood Banks).

Y-STR WORDING

REQUIRED STATEMENTS (PLACED AFTER RESULTS):

DNA Profiles Generated Using PowerPlex® Y23:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

In the DNA analysis detailed above, the following Y-STR loci were analyzed by Polymerase Chain Reaction (PCR): DYS576, DYS389 I, DYS448, DYS389 II, DYS19, DYS391, DYS481, DYS549, DYS533, DYS438, DYS437, DYS570, DYS635, DYS390, DYS439, DYS392, DYS643, DYS393, DYS458, DYS385 a/b, DYS456, and Y-GATA-H4.

OR

No Samples Amplified:

Quantification was performed in the Y-STR analysis of the samples(s) detailed above.

SINGLE SOURCE STATEMENTS:

Use Of Exclusionary Statement (Full Profile Obtained From Sample; Standard Is Excluded):

Item XA The Y-STR profile obtained [from *item description* (item XA)] is consistent with an unknown male. *John Doe* (item XA) can be excluded as a contributor to the sample.

Use Of Consistent Statement (Full Profile Obtained From Sample; No Differences From Standard):

Item XA The Y-STR profile obtained [from *item description* (item XA)] is consistent with the Y-STR profile obtained from *John Doe* (item XA). Therefore, *John Doe* and all his male paternal relatives cannot be excluded as potential Y-STR contributors to the sample. Utilizing the U.S Y-STR Database on *January 1, 2014* the Y-STR profile has been observed as follows:

<u>POPULATION</u>	<u>HAPLOTYPE OBSERVED</u>	<u>95% UPPER CONFIDENCE INTERVAL</u>
Caucasian	0 in 5758	1 in 1923
African American	0 in 4664	1 in 1558
Hispanic	0 in 3008	1 in 1005

Use Of Consistent Statement (Full Profile Obtained From Sample; No Differences From Standard with additional allele):

Item XA The Y-STR profile obtained [from *item description* (item XA)] is consistent with the Y-STR profile obtained from *John Doe* (item XA); however, *an/one* additional allele was detected. Therefore, *John Doe* and all his male paternal relatives cannot be excluded as potential Y-STR contributors to the sample. No conclusion can be made regarding

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

the additional allele. Utilizing the U.S Y-STR Database on *January 1, 2014* the Y-STR profile has been observed as follows:

<u>POPULATION</u>	<u>HAPLOTYPE OBSERVED</u>	<u>95% UPPER CONFIDENCE INTERVAL</u>
Caucasian	0 in 5758	1 in 1923
African American	0 in 4664	1 in 1558
Hispanic	0 in 3008	1 in 1005

Partial Profile Obtained from Sample:

Item XA The partial Y-STR profile obtained [from *item description* (item XA)] is consistent with the Y-STR profile obtained from *John Doe* (item XA). Therefore, *John Doe* and all his male paternal relatives cannot be excluded as potential Y-STR contributors to the sample. Utilizing the U.S Y-STR Database on *January 1, 2014* the Y-STR profile has been observed as follows:

<u>POPULATION</u>	<u>HAPLOTYPE OBSERVED</u>	<u>95% UPPER CONFIDENCE INTERVAL</u>
Caucasian	0 in 5758	1 in 1923
African American	0 in 4664	1 in 1558
Hispanic	0 in 3008	1 in 1005

MIXTURE STATEMENTS:

Indistinguishable Mixture:

Item XA The Y-STR result obtained [from *item description* (item XA)] demonstrated the presence of a mixture of at least two male individuals. The results do not qualify for statistical calculations; therefore, no conclusions can be drawn.

Distinguishable Major And Minor Components:

Item XA The Y-STR result obtained [from *item description* (item XA)] demonstrated the presence of a mixture with a major profile. The major Y-STR profile is consistent with *John Doe* (item XA). Therefore, *John Doe* and all his male paternal relatives cannot be excluded as potential Y-STR contributors to the sample. No conclusion can be drawn from the remaining alleles. Utilizing the U.S. Y-STR Database on *January 1, 2014*, the major Y-STR profile has been observed as follows:

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

<u>POPULATION</u>	<u>HAPLOTYPE OBSERVED</u>	<u>95% UPPER CONFIDENCE INTERVAL</u>
Caucasian	0 in 5758	1 in 1923
African American	0 in 4664	1 in 1558
Hispanic	0 in 3008	1 in 1005

SAMPLES UNSUITABLE FOR COMPARISON:

Item XA	Due to the limited quantity and/or quality of the sample, the Y-STR profile obtained [from <i>item description</i> (item XA)] failed to demonstrate conclusive results.
<i>Item XA</i>	<i>Item description</i> failed to demonstrate a Y-STR profile.
Item XA	No conclusion can be drawn regarding <i>item description</i> (item XA) because <i>the/a</i> test control(s) did not meet required parameters.

SAMPLES NOT AMPLIFIED:

Item XA	<i>Item description</i> failed to demonstrate a sufficient quantity of male DNA for further Y-STR analysis.
Item XA	<i>Item description</i> (item XA) was quantified; however, no further Y-STR analysis was performed at this time.
Item XA	No further Y-STR analysis was performed on the DNA standard of <i>John Doe</i> (item XA) due to a lack of evidence for comparison.

SAMPLE/SUBITEM NOT EXAMINED:

Item XA	No Y-STR analysis was performed on # additional samples at this time.
Item XA	No Y-STR analysis was performed on the DNA standard of <i>John Doe</i> (item XA) due to a lack of evidence for comparison.

Upon evaluation, no samples were determined to be suitable for Y-STR analysis.

IDENTIFICATION OF CONTAMINATION FROM LABORATORY PERSONNEL (Not all possible continuations are given, consultation with the Technical Leader and/or Supervisor is recommended):

**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS**

Item XA No Y-STR profile of apparent value was identified on *item description* (item XA). The Y-STR profile of a *laboratory analyst/non-laboratory person* was identified.

Item XA The Y-STR result obtained from *item description* (item XA) demonstrated the presence of a mixture with a major profile. The major Y-STR profile is consistent with the Y-STR profile of a *laboratory analyst/non-laboratory person*.

REQUESTS FOR STANDARDS:

Additional Y-STR comparisons will be made upon submission of an appropriate male DNA standard(s) (such as a blood standard in a purple top tube or an oral swab standard).

WORDING OF STATISTICAL ANALYSIS:

When A Calculation With A Frequency Is Reported The Following Paragraph Shall Be Added:

Note: Statistical estimates were performed based on the recommended concepts endorsed by the Scientific Working Group on DNA Analysis Methods (1/9/14). Loci from the PowerPlex® Y kit and from the PowerPlex® Y23 kit have been searched, with the statistical estimate providing the most genetic information reported.

CODIS STATEMENT (Placed At The End of Any Report Detailing New Profiles):

At this time, Y-STR profiles cannot be entered or searched in the Indiana DNA Database.

**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS
APPENDIX 6 DEFINITIONS**

1. Acid Phosphatase – a chemical component of semen; also found in other body fluids at significantly lower concentrations.
2. Allele – the alternative form of a gene.
3. Allele Frequency – the proportion of a particular allele found in a population.
4. Allelic Ladder – a set of DNA fragments of the commonly known alleles for each locus. By comparing the samples to the allelic ladder, the correct allele designation may be assigned.
5. Ambiguous Zygosity – a locus where a single allele is present in which it is unclear if the locus is homozygous or if the sister allele is dropped out or masked.
6. Amelogenin – the marker for determining the gender of the individual contributor to a DNA profile.
7. Amplification – using the PCR process to create many copies of a specific DNA sequence(s). An increase in the number of copies of a specific DNA fragment.
8. Amylase – a chemical component of saliva; also found in other body fluids.
9. Analyst Discretion - the use of individual judgment, based on an analyst's training and experience to determine the optimum modes of analysis for an item of evidence.
10. Artifact – non-allelic product of the amplification process, an anomaly of the detection process, or a by-product of primer synthesis. A data peak that does not represent a true allele.
11. Base Pairs – paired nucleotides which make up the DNA molecule. Two complementary nucleotides joined by a hydrogen bonds.
12. Blood – the fluid that circulates through the body, containing red and white blood cells carrying oxygen and nutrients to cells throughout the body; and carrying away waste and carbon dioxide.
13. Capillary Electrophoresis – a method to separate DNA fragments based on size using electrical current. The DNA sample is placed in thin tube (capillary) containing gel (polymer) and subjected to high voltage current allowing the DNA fragments to migrate through the tube.
14. Chromosome – the structure on which genes are naturally arranged and how DNA is organized.
15. Combined DNA Index System (CODIS) – refers to the DNA database and its software. It is composed of National (NDIS), State (SDIS), and Local (LDIS) components. It contains DNA profiles from offenders, crime scenes and includes a missing person database.
16. Combined Probability of Inclusion/ Combined Probability of Exclusion (CPI/CPE) – statistical method for calculating the inclusion/exclusion of a random person in a profile that has more than one person present.
17. Contamination – the process of making a sample impure or unusable.
18. Deconvoluted – a mixed DNA profile that has been resolved into separate components based on stated assumptions and quantitative peak height information.
19. Deduced – the inference of an unknown contributor's DNA profile after taking into consideration the contribution of an assumed contributor's DNA profile in an intimate sample based on quantitative peak height information.
20. Degradation – the breaking down of the DNA molecule into smaller fragments.
21. Denaturation – the separation of the double stranded DNA molecule into two single strands.
22. Deoxyribonucleic Acid (DNA) - the genetic material present in the nucleus of most cells. Also located in cell mitochondria.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

23. DNA Sequence - a specific order of base pairs.
24. Electropherogram – the visual representation of the DNA fragments contained in each sample; generated by the analysis software of the Capillary Electrophoresis Instrument.
25. Electrophoresis – the method to separate molecules based on their size by placing them in a medium and applying a electrical current. The molecules will travel through the medium at different rates, the smaller molecules traveling through the medium more quickly than the larger ones.
26. Enzyme – a protein which acts as a catalyst, speeding up a specific chemical reaction without being changed or consumed in the process.
27. Epithelial Cells – skin cells and other surface cells such as from the mouth (buccal cells) or the vaginal cavity.
28. Gene – the basic functional unit of heredity. Most genes determine the structure and function of proteins.
29. Genotype – the specific genetic sequence of a person's DNA.
30. Hair – a slender outgrowth from the skin of mammals.
31. Heme – the iron containing complex of the hemoglobin molecule.
32. Hemin – the oxidized heme molecule.
33. Hemoglobin - the iron containing protein in blood.
34. Heterozygous – having different alleles at a particular locus.
35. Homozygous – having two of the same allele at a particular locus.
36. Internal Lane Standard (ILS) – a set of DNA fragments of known length(s). The ILS is simultaneously injected with all DNA samples during electrophoresis. This allows accurate measurement of the length of each allele in a DNA sample.
37. Intimate samples – biological sample that is obtained directly from an individual's body.
38. Locus (loci) – the physical location of a gene on a chromosome.
39. Marker – a gene of known location and phenotype used as a point of reference.
40. Meaningful profile – a profile that is developed from an item or location where the individual's profile would not reasonably be expected. A person's profile may be expected on an item or sample from their own body, their own clothing, or their property such as their house or vehicle. All other samples will generally be considered meaningful.
41. Minimum allele frequency - a conservative frequency correction for alleles observed less than 5 times in the STR population frequency tables.
42. Mitochondria - a part of a cell used in energy production. Contains circular DNA inherited from the mother only.
43. Modified Random Match Probability - an estimate based on the assumption of the number of contributors within a sample, of the probability of selecting an unrelated individual at random that would be included as a potential contributor to the mixed profile.
44. Nucleus - the part of a cell that contains the double stranded DNA inherited from both parents.
45. Obligate allele – an allele in a mixed DNA typing result that is a) foreign to an assumed contributor, or b) based on quantitative peak height information, determined to be shared with the assumed contributor.
46. Partial profile – DNA profile for which typing results were not obtained for all tested loci.
47. Phenotype – the expressed genotype.
48. Polymerase – an enzyme that initiates the duplication of a DNA molecule.
49. Polymerase Chain Reaction (PCR) – a process for amplifying (copying) the DNA molecule.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

- 50. Polymorphism – the presence of more than one possible allele set for a specific gene.
- 51. Population – a stable group of random individuals, chosen for genetic analysis.
- 52. Primer – a short nucleotide fragment of known sequence used to locate its complementary sequence on the DNA molecule for the initiation of PCR. Primers target the specific loci to be amplified.
- 53. Proficiency Testing – a test to evaluate the competency of an analyst in a specific procedure.
- 54. Random Match Probability (RMP) - the probability of obtaining a match between two distinct and unrelated individuals.
- 55. Saliva – digestive fluid from the mouth. Saliva contains elevated levels of amylase.
- 56. Semen/Seminal Fluid – the male ejaculate. In a dried state may be referred to as seminal material. Semen normally contains spermatozoa.
- 57. Short Tandem Repeat (STR) – small sections of DNA that contain short segments (2, 3, 4 or more base pairs) which repeat several times. The number of repeat units may vary between individuals. STRs are located between specific genes and are considered non-functional.
- 58. Source attribution - a RMP threshold at which a degree of confidence can be assured that a questioned sample can be attributed to a known reference sample.
- 59. Spermatozoa – the male reproductive cell, sperm cell.
- 60. Stochastic effect – peak imbalance observed in a locus and/or allele drop-out due to random, disproportionate amplification of alleles in low quality/quantity template samples.
- 61. Stutter – an artifact that occurs as a by-product of the PCR process. It is observed as a minor peak typically observed one repeat unit smaller than a primary STR allele caused by strand slippage during amplification.
- 62. Substrate – the material on which a biological sample is deposited such as at a crime scene.
- 63. SWGDAM – Scientific Working Group on DNA Analysis Methods.
- 64. Theta - a value to adjust for population substructure in homozygous loci.
- 65. Validation – a study to assess whether a particular procedure (or instrument) can obtain a desired result reliably and reproducibly. The study includes looking at the conditions necessary to obtain those results and the limitations of the procedure/instrument. All DNA analysis methods shall be validated prior to implementation.
- 66. Work Product – the material that is generated as a function of analysis, which may include extracts and amplified product, in tubes or plates, and any aliquots thereof.
- 67. X Chromosome – a sex chromosome, present twice in female cells and once in male cells.
- 68. Y Chromosome – a sex chromosome, present once in male cells (and absent in female cells), paired with the X chromosome.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS APPENDIX 7 DNA SERVER INSTRUCTIONS

The DNA servers will be used in place of CDs for storage and archiving of data and photos. Real Time PCR SDS files, 3500 run folders, GeneMapper® *ID-X* projects and photos will be saved to the server. Any worksheets, statistic sheets, typed notes pages, or workbooks shall NOT be saved to the server. The printed copy that will be scanned into LIMS upon completion of the case will be the official, tracked copy. We want to avoid duplication of items between LIMS and the server.

On the server, each analyst will have a folder that only he will be able to write to. Other analysts will be able to view items in the folder, but will not be able to change, delete or add items within the folder. Within the analyst's folder there will be one folder for each laboratory case number and request. Each folder will contain all associated data for that request. Any projects or run folders that contain batched data will be saved individually within each of the associated case folders. The following nomenclature shall be used:

Analyst's Folder (created by Lab IT)

- Laboratory case and request folder – “case number_request number” – ex. “10I1234_1” – the request number corresponds to the laboratory request number assigned in LIMS.
 - RT-PCR SDS projects: “1st case on the plate_date_plate#” – ex. “10I1234_01Jan11_01”
 - 3500 run folder: “1st case on the plate_date_plateinjection#” – ex. “10I1234_01Jan11_01” – plate injection number indicates how many times that plate preparation has been put in the instrument for injection; if the same plate preparation is run on a different date, the original date should still be used from when the plate was prepared. If a second preparation of a plate is made on the same date as the first, it shall be designated with a “-2” after the date. Ex. “10I1234_01Jan11-2_01”
 - GeneMapper® *ID-X* project name: must contain the injection protocol and date the run was started (in most cases the same as the date in the run folder name)- ex. “3kV3sec_01Jan11”, “10I1234_3kV3sec_01Jan11” or “Controls_3kV3sec_01Jan11”
 - Photos: create a folder per item photographed – folder name “case_item#” ex. “10I1234_item1”. The individual photo file names are left to the analyst's discretion.

Note: RT-PCR and 3500 Plates generated by the automation team may substitute Batch ID # for Lab Case #. RT-PCR plate names generated by the automation team shall also include the automation analyst initials and PE number.

Note: For RT-PCR SDS projects and 3500 run folders – only the first case on the plate should be included in the name. Do not write more than one case number and do not write “et al.” after the name.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS APPENDIX 8

RELATIONSHIP COMPARISON STATISTICAL REFERENCE SHEET

Formulas for Paternity Index (PI) and Random Man Not Excluded (RMNE) (Table below adapted from the AABB, Standards for Relationship Testing Laboratories, 9th Edition, Appendix 7 and 8)

Mother	Child	Alleged Father	PI	RMNE	PE
BD	AB	AC	$1/2a$	$1-(1-a)^2$	$(1-a)^2$
BC	AB	AC	$1/2a$	$1-(1-a)^2$	$(1-a)^2$
BC	AB	AB	$1/2a$	$1-(1-a)^2$	$(1-a)^2$
BC	AB	A	$1/a$	$1-(1-a)^2$	$(1-a)^2$
B	AB	AC	$1/2a$	$1-(1-a)^2$	$(1-a)^2$
B	AB	AB	$1/2a$	$1-(1-a)^2$	$(1-a)^2$
B	AB	A	$1/a$	$1-(1-a)^2$	$(1-a)^2$
AB	AB	AC	$1/[2(a+b)]$	$1-(1-a-b)^2$	$(1-a-b)^2$
AB	AB	AB	$1/(a+b)$	$1-(1-a-b)^2$	$(1-a-b)^2$
AB	AB	A	$1/(a+b)$	$1-(1-a-b)^2$	$(1-a-b)^2$
AB	A	AC	$1/2a$	$1-(1-a)^2$	$(1-a)^2$
AB	A	AB	$1/2a$	$1-(1-a)^2$	$(1-a)^2$
AB	A	A	$1/a$	$1-(1-a)^2$	$(1-a)^2$
A	A	AB	$1/2a$	$1-(1-a)^2$	$(1-a)^2$
A	A	A	$1/a$	$1-(1-a)^2$	$(1-a)^2$
	AB	AC	$1/4a$	$1-(1-a-b)^2$	$(1-a-b)^2$
	AB	AB	$(a+b)/4ab$	$1-(1-a-b)^2$	$(1-a-b)^2$
	AB	A	$1/2a$	$1-(1-a-b)^2$	$(1-a-b)^2$
	A	AC	$1/2a$	$1-(1-a)^2$	$(1-a)^2$
	A	A	$1/a$	$1-(1-a)^2$	$(1-a)^2$

Paternity Index for Mutations

$$PI = \mu / [PE] \quad \mu = \text{mutation rate for the locus}$$

Combined Paternity Index (CPI)

$$CPI = PI_1 \times PI_2 \times PI_3 \dots$$

Probability of Paternity (W)

$$W = CPI \times Pr / [CPI \times Pr + (1-Pr)]$$

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

Formulas for Reverse Paternity

(Table below adapted from the AABB, Guidelines for Mass Fatality DNA Identification Operations, 2010, Appendix B)

Mother	Possible Child	Father	Formula
A	A	AB	$1/2a^2$
A	AB	AB	$1/4ab$
A	AB	BC	$1/4ab$
AB	A	AB	$1/4a^2$
AB	A	AC	$1/4a^2$
BC	AB	AB	$1/8ab$
BC	AB	AC	$1/8ab$
BD	AB	AC	$1/8ab$
A	A	A	$1/a^2$
AB	A	A	$1/2a^2$
B	AB	A	$1/2ab$
BC	AB	A	$1/4ab$
AB	AB	AC	$1/8ab$
AB	AB	A	$1/4ab$
AB	AB	AB	$1/4ab$

Formulas for Sibship

(Table below adapted from the AABB, Guidelines for Mass Fatality DNA Identification Operations, 2010, Appendix B)

Sibling	Possible Full Sibling	Formula
AB	AB	$(1+a+b+2ab)/8ab$
A	A	$(1+a)^2/(2a)^2$
A	AB	$(1+a)/4a$
AB	AC	$(1+2a)/8a$
AB	CD	$1/4$

Half Sibling	Possible Half Sibling	Formula
AB	AB	$(a+b+4ab)/8ab$
A	A	$(1+a)/2a$
A	AB	$(1+2a)/4a$
AB	AC	$(1+4a)/8a$
AB	CD	$1/2$

STR Population Data

Budowle, B., Shea, B., Niezgoda, S., Chakraborty, R. CODIS STR Loci Data from 41 Sample Populations. J. Forensic Sci. 2001; 48(3): 453-489

Levandakou, E. N., et al. Allele Frequencies for Fourteen STR Loci of the Powerplex™ 1.1 and 2.1 Multiplex Systems and Penta D Locus in Caucasians, African-Americans, Hispanics, and Other Populations of the United States of America and Brazil. J. Forensic Sci. 2001; 48(3): 736-761.

**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS
APPENDIX 9
POWERPLEX® Y23 STUTTER TABLE**

Locus	Stutter	Mean% Stutter	Mean+3SD
DYS576	n-4	9.82	12.57
	n+4	1.39	4.00
	n-8	0.74	1.78
DYS389I	n-4	5.51	7.14
	n+4	0.44	1.12
	n-8	0.57	1.50
DYS448	n-6	2.17	2.55
DYS389II	n-4	11.32	14.80
	n+4	1.05	2.44
	n-8	1.23	2.30
DYS19	n-4	5.71	8.48
	n-2	7.76	9.09
	n+2	2.81	4.36
	n+4	0.66	1.55
DYS391	n-4	7.00	9.74
	n-8	0.71	2.19
	n-2	0.50	1.05
	n+4	0.70	4.01
DYS481	n-3	17.78	25.93
	n+3	2.52	5.12
	n-6	3.05	5.04
DYS549	n-4	6.61	9.66
	n+4	1.11	2.02
	n-8	0.99	1.69
DYS533	n-4	6.68	9.05
	n+4	0.99	2.19
	n-8	0.69	1.68
DYS438	n-5	3.03	5.10
	n+5	0.66	1.61
DYS437	n-4	4.94	7.96
	n+4	0.69	1.75
	n-8	0.69	0.98
DYS570	n-4	9.26	14.41
	n+4	0.90	1.88
	n-8	0.69	1.30

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

DYS635	n-4	6.27	10.67
	n+4	0.48	1.26
	n-8	0.69	1.74
DYS390	n-4	8.55	12.80
	n+4	0.44	1.14
	n-8/n-9	1.01	2.67
DYS439	n-4	6.06	9.19
	n+4	0.87	2.31
	n-8	0.51	1.02
DYS392	n-3	9.64	14.09
	n+3	5.93	12.11
	n-6	1.09	2.23
DYS643	n-5	2.33	5.41
	n+5	0.50	1.31
DYS393	n-4	9.78	13.05
	n+4	1.44	2.71
	n-8	1.03	1.97
DYS458	n-4	9.73	12.71
	n+4	0.80	1.88
	n-8	0.84	1.31
DYS385	n-4	7.89	14.14
	n+4	0.82	1.58
	n-8	1.09	2.22
DYS456	n-4	10.71	15.71
	n+4	1.85	2.68
	n-8	1.37	2.93
Y-GATA-H4	n-4	7.41	10.05
	n+4	1.44	2.25
	n-8	1.09	2.10

**INDIANA STATE POLICE
FORENSIC BIOLOGY SECTION
TEST METHODS
APPENDIX 10
Allele Frequency Tables
(Autosomal Loci)**

In May 2015 the FBI notified the forensic community of errors in the allele frequencies published in their 1999 article "Population data on the thirteen CODIS core short tandem repeat loci in African Americans, US Caucasians, Hispanics, Bahamians, Jamaicans, and Trinidadians." (Bruce Budowle, Tamyra R. Moretti, et al. Journal of Forensic Sciences 1999; Volume 44, Number 6). The erratum, which included corrections to the allele frequencies and a description of the expected effects on statistics, was published in July 2015 (Moretti, T. R., Budowle, B. and Buckleton, J. S. Journal of Forensic Sciences 2015; Volume 60, Number 4).

The following allele frequency tables include the updated allele frequencies for core CODIS loci as provided by the FBI DNA Support Unit in June 2015. Highlighted frequencies were those affected by the FBI's erratum.

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

D3				D21				D18			
Allele	AA	CA	HISP	Allele	AA	CA	HISP	Allele	AA	CA	HISP
0	1	1	1	0	1	1	1	0	1	1	1
<12	0.0119	0.0124	0.012	<24	0.014	0.0128	0.0123	<8	0.0140	0.0128	0.0123
12	0.0119	0.0124	0.012	24	0.014	0.0128	0.0123	8	0.0140	0.0128	0.0123
13	0.0119	0.0124	0.012	24.2	0.014	0.0128	0.0123	9	0.0140	0.0128	0.0123
14	0.1214	0.1386	0.0789	24.3	0.014	0.0128	0.0123	10	0.0140	0.0128	0.0123
15	0.2905	0.2475	0.4258	25	0.014	0.0128	0.0123	10.2	0.0140	0.0128	0.0123
15.2	0.0119	0.0124	0.012	25.2	0.014	0.0128	0.0123	11	0.0140	0.0128	0.0123
16	0.3071	0.2327	0.2656	26	0.014	0.0128	0.0123	12	0.0587	0.1276	0.1059
17	0.2	0.2104	0.1268	26.2	0.014	0.0128	0.0123	13	0.0559	0.1224	0.17
17.1	0.0119	0.0124	0.012	27	0.0615	0.0459	0.0123	13.2	0.0140	0.0128	0.0123
18	0.0548	0.1634	0.0837	28	0.2151	0.1658	0.069	14	0.0642	0.1735	0.17
19	0.0119	0.0124	0.0144	28.2	0.014	0.0128	0.0123	14.2	0.0140	0.0128	0.0123
20	0.0119	0.0124	0.012	29	0.1899	0.1811	0.2044	15	0.1676	0.1276	0.1379
>20	0.0119	0.0124	0.012	29.2	0.014	0.0128	0.0123	15.2	0.0140	0.0128	0.0123
micro	0.0119	0.0124	0.012	29.3	0.014	0.0128	0.0123	16	0.1872	0.1071	0.1158
micro2	0.0119	0.0124	0.012	30	0.1788	0.2321	0.33	16.2	0.0140	0.0128	0.0123
N	210	202	209	30.2	0.014	0.0383	0.032	17	0.1620	0.1556	0.1379
5/2N	0.0119	0.0124	0.012	30.3	0.014	0.0128	0.0123	18	0.1313	0.0918	0.0517
				31	0.0922	0.0714	0.069	19	0.0782	0.0357	0.0369
				31.1	0.014	0.0128	0.0123	20	0.0559	0.0255	0.0172
TH01				31.2	0.0754	0.102	0.0862	20.2	0.0140	0.0128	0.0123
Allele	AA	CA	HISP	32	0.014	0.0153	0.0123	21	0.0140	0.0128	0.0197
0	1	1	1	32.1	0.014	0.0128	0.0123	21.2	0.0140	0.0128	0.0123
<4	0.0119	0.0124	0.012	32.2	0.0698	0.1097	0.1355	22	0.0140	0.0128	0.0123
4	0.0119	0.0124	0.012	32.3	0.014	0.0128	0.0123	23	0.0140	0.0128	0.0123
5	0.0119	0.0124	0.012	33	0.014	0.0128	0.0123	24	0.0140	0.0128	0.0123
6	0.1095	0.2252	0.2321	33.1	0.014	0.0128	0.0123	25	0.0140	0.0128	0.0123
7	0.4405	0.1733	0.3373	33.2	0.0335	0.0306	0.0419	26	0.0140	0.0128	0.0123
8	0.1857	0.1262	0.0813	33.3	0.014	0.0128	0.0123	27	0.0140	0.0128	0.0123
8.3	0.0119	0.0124	0.012	34	0.014	0.0128	0.0123	>27	0.0140	0.0128	0.0123
9	0.1452	0.1658	0.1029	34.1	0.014	0.0128	0.0123	micro	0.0140	0.0128	0.0123
9.3	0.1048	0.3045	0.2416	34.2	0.014	0.0128	0.0123	micro2	0.0140	0.0128	0.0123
10	0.0143	0.0124	0.012	35	0.0279	0.0128	0.0123	N	179	196	203
11	0.0119	0.0124	0.012	35.2	0.014	0.0128	0.0123	5/2N	0.0140	0.0128	0.0123
13.3	0.0119	0.0124	0.012	36	0.014	0.0128	0.0123				
micro	0.0119	0.0124	0.012	37	0.014	0.0128	0.0123				
micro2	0.0119	0.0124	0.012	38	0.014	0.0128	0.0123				
N	210	202	209	>38	0.014	0.0128	0.0123				
5/2N	0.0119	0.0124	0.012	micro	0.014	0.0128	0.0123				
				micro2	0.014	0.0128	0.0123				
				N	179	196	203				
				5/2N	0.014	0.0128	0.0123				

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

PENTA E				D5				FGA			
Allele	AA	CA	HISP	Allele	AA	CA	HISP	Allele	AA	CA	HISP
0	1	1	1	0	1	1	1	0	1	1	1
<5	0.018	0.015	0.012	<7	0.0139	0.0128	0.0123	<16	0.0139	0.0128	0.0123
5	0.14	0.067	0.031	7	0.0139	0.0128	0.0616	16	0.0139	0.0128	0.0123
6	0.018	0.015	0.012	8	0.05	0.0128	0.0123	17	0.0139	0.0128	0.0123
7	0.133	0.174	0.079	9	0.0139	0.0308	0.0542	18	0.0139	0.0306	0.0123
8	0.14	0.015	0.038	9.2	0.0139	0.0128	0.0123	18.2	0.0139	0.0128	0.0123
9	0.054	0.015	0.012	10	0.0639	0.0487	0.064	19	0.0528	0.0561	0.0813
10	0.05	0.093	0.038	11	0.2611	0.4103	0.4261	19.2	0.0139	0.0128	0.0123
11	0.05	0.102	0.062	12	0.3556	0.3538	0.2882	19.3	0.0139	0.0128	0.0123
12	0.122	0.209	0.189	13	0.2444	0.1462	0.0961	20	0.0722	0.1454	0.069
13	0.126	0.096	0.115	14	0.0139	0.0128	0.0123	20.2	0.0139	0.0128	0.0123
14	0.05	0.061	0.081	15	0.0139	0.0128	0.0123	21	0.125	0.1735	0.1305
15	0.04	0.038	0.103	16	0.0139	0.0128	0.0123	21.2	0.0139	0.0128	0.0123
16	0.047	0.049	0.084	>16	0.0139	0.0128	0.0123	22	0.225	0.1888	0.1773
17	0.032	0.049	0.055	micro	0.0139	0.0128	0.0123	22.2	0.0139	0.0128	0.0123
18	0.018	0.017	0.033	micro2	0.0139	0.0128	0.0123	22.3	0.0139	0.0128	0.0123
19	0.018	0.015	0.022	N	180	195	203	23	0.125	0.1582	0.1404
20	0.018	0.015	0.031	5/2N	0.0139	0.0128	0.0123	23.2	0.0139	0.0128	0.0123
20.3	0.018	0.015	0.12					23.3	0.0139	0.0128	0.0123
21	0.018	0.015	0.022	D13				24	0.1861	0.1378	0.1256
22	0.018	0.015	0.012	Allele	AA	CA	HISP	24.2	0.0139	0.0128	0.0123
23	0.018	0.015	0.012	0	1	1	1	24.3	0.0139	0.0128	0.0123
24	0.018	0.015	0.012	<7	0.014	0.0128	0.0123	25	0.1	0.0689	0.1379
>24	0.018	0.015	0.012	7	0.014	0.0128	0.0123	25.1	0.0139	0.0128	0.0123
micro	0.018	0.015	0.012	8	0.0335	0.0995	0.0665	25.2	0.0139	0.0128	0.0123
micro2	0.018	0.015	0.012	8.1	0.014	0.0128	0.0123	25.3	0.0139	0.0128	0.0123
N	139	172	209	9	0.0279	0.0765	0.2192	26	0.0361	0.0179	0.0837
5/2N	0.018	0.015	0.012	10	0.0503	0.051	0.101	26.2	0.0139	0.0128	0.0123
				11	0.2374	0.3214	0.202	27	0.0222	0.0128	0.032
TPOX				12	0.4832	0.3061	0.2167	27.2	0.0139	0.0128	0.0123
Allele	AA	CA	HISP	13	0.1257	0.1097	0.1379	28	0.0167	0.0128	0.0123
0	1	1	1	13.3	0.014	0.0128	0.123	29	0.0139	0.0128	0.0123
<6	0.012	0.0124	0.012	14	0.0391	0.0357	0.0567	30	0.0139	0.0128	0.0123
6	0.0861	0.0124	0.012	15	0.014	0.0128	0.0123	30.2	0.0139	0.0128	0.0123
7	0.0215	0.0124	0.012	>15	0.014	0.0128	0.0123	31	0.0139	0.0128	0.0123
8	0.3684	0.547	0.555	micro	0.014	0.0128	0.0123	31.2	0.0139	0.0128	0.0123
9	0.1818	0.1238	0.0335	micro2	0.014	0.0128	0.0123	>31.2	0.0139	0.0128	0.0123
10	0.0933	0.0371	0.0335	N	179	196	203	43.2	0.0139	0.0128	0.0123
11	0.2249	0.255	0.2727	5/2N	0.014	0.0128	0.0123	44.2	0.0139	0.0128	0.0123
12	0.0239	0.0371	0.0933					45.2	0.0139	0.0128	0.0123
13	0.012	0.0124	0.012					46.2	0.0139	0.0128	0.0123
>13	0.012	0.0124	0.012					>46.2	0.0139	0.0128	0.0123
micro	0.012	0.0124	0.012					micro	0.0139	0.0128	0.0123
micro2	0.012	0.0124	0.012					micro2	0.0139	0.0128	0.0123
N	209	202	209					N	180	196	203
5/2N	0.012	0.0124	0.012					5/2N	0.0139	0.0128	0.0123

INDIANA STATE POLICE FORENSIC BIOLOGY SECTION TEST METHODS

D7				CSF				vWA			
Allele	AA	CA	HISP	Allele	AA	CA	HISP	Allele	AA	CA	HISP
0	1	1	1	0	1	1	1	0	1	1	1
<6	0.0119	0.0124	0.012	<6	0.0119	0.0124	0.012	10	0.0139	0.0128	0.0123
6	0.0119	0.0124	0.012	6	0.0119	0.0124	0.012	11	0.0139	0.0128	0.0123
6.3	0.0119	0.0124	0.012	7	0.0429	0.0124	0.012	12	0.0139	0.0128	0.0123
7	0.0119	0.0173	0.0215	8	0.0857	0.0124	0.012	13	0.0139	0.0128	0.0123
8	0.1738	0.1634	0.0981	9	0.0333	0.0198	0.012	14	0.0667	0.102	0.0616
8.1	0.0119	0.0124	0.012	10	0.2714	0.2525	0.2536	15	0.2361	0.1122	0.0714
8.2	0.0119	0.0124	0.012	10.3	0.0119	0.0124	0.012	16	0.2694	0.2015	0.3645
9	0.1571	0.146	0.0478	11	0.2048	0.2995	0.2656	17	0.1833	0.2628	0.2217
9.1	0.0119	0.0124	0.012	11.1	0.0119	0.0124	0.012	18	0.1361	0.2219	0.1946
9.3	0.0119	0.0124	0.012	12	0.3	0.3267	0.3923	19	0.0722	0.0842	0.0714
10	0.3238	0.2896	0.3062	12.1	0.0119	0.0124	0.012	20	0.0278	0.0128	0.0123
10.1	0.0119	0.0124	0.012	13	0.0548	0.0718	0.0646	21	0.0139	0.0128	0.0123
10.3	0.0119	0.0124	0.012	14	0.0119	0.0149	0.012	22	0.0139	0.0128	0.0123
11	0.2238	0.203	0.2895	15	0.0119	0.0124	0.012	>22	0.0139	0.0128	0.0123
11.3	0.0119	0.0124	0.012	micro	0.0119	0.0124	0.012	micro	0.0139	0.0128	0.0123
12	0.0905	0.1411	0.1914	micro2	0.0119	0.0124	0.012	micro2	0.0139	0.0128	0.0123
13	0.019	0.0297	0.0383	N	210	202	209	N	180	196	203
14	0.0119	0.0124	0.012	5/2N	0.0119	0.0124	0.012	5/2N	0.0139	0.0128	0.0123
>14	0.0119	0.0124	0.012								
micro	0.0119	0.0124	0.012	PENTA D				D8			
micro2	0.0119	0.0124	0.012	Allele	AA	CA	HISP	Allele	AA	CA	HISP
N	210	202	209	0	1	1	1	0	1	1	1
5/2N	0.0119	0.0124	0.012	2.2	0.122	0.015	0.012	<7	0.0139	0.0128	0.0123
				3.2	0.018	0.015	0.012	7	0.0139	0.0128	0.0123
D16				5	0.047	0.015	0.012	8	0.0139	0.0179	0.0123
Allele	AA	CA	HISP	6	0.018	0.015	0.012	9	0.0139	0.0128	0.0123
0	1	1	1	7	0.022	0.015	0.012	10	0.025	0.102	0.0936
<5	0.012	0.0124	0.012	8	0.147	0.015	0.024	11	0.0361	0.0587	0.0616
5	0.012	0.0124	0.012	9	0.14	0.172	0.186	12	0.1083	0.1454	0.1207
<8	0.012	0.0124	0.012	10	0.101	0.116	0.186	13	0.2222	0.3393	0.3251
8	0.0359	0.0199	0.0168	11	0.169	0.148	0.176	14	0.3333	0.2015	0.2463
9	0.1986	0.1045	0.0793	12	0.108	0.238	0.157	15	0.2139	0.1097	0.1158
10	0.11	0.0647	0.1755	13	0.104	0.209	0.179	16	0.0444	0.0128	0.0246
11	0.2943	0.2736	0.3149	14	0.018	0.055	0.055	17	0.0139	0.0128	0.0123
11.3	0.012	0.0124	0.012	15	0.018	0.026	0.012	18	0.0139	0.0128	0.0123
12	0.1866	0.3383	0.2885	16	0.018	0.015	0.012	>18	0.0139	0.0128	0.0123
13	0.1651	0.1642	0.101	17	0.018	0.015	0.012	micro	0.0139	0.0128	0.0123
14	0.012	0.0323	0.024	>17	0.018	0.015	0.012	micro2	0.0139	0.0128	0.0123
15	0.012	0.0124	0.012	micro	0.018	0.015	0.012	N	180	196	203
>15	0.012	0.0124	0.012	micro2	0.018	0.015	0.012	5/2N	0.0139	0.0128	0.0123
micro	0.012	0.0124	0.012	N	139	172	210				
micro2	0.012	0.0124	0.012	5/2N	0.018	0.015	0.012				
N	209	201	208								
5/2N	0.012	0.0124	0.012								